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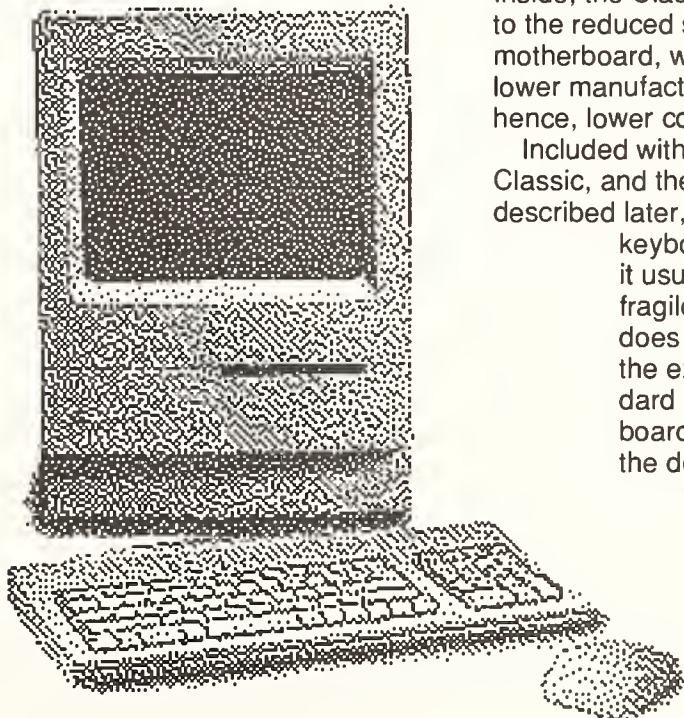
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Hardware

Low-cost Macs

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Since its introduction in 1984, the Macintosh computer has been criticized for its lack of speed and its high cost. Earlier this year we were treated to the extremely fast Macintosh IIx, so we have stopped complaining about the speed issue. Now, Apple Computer hopes that October 15 will mark the day we stopped complaining about the high cost. While users will ultimately determine the success of the new Macintosh models announced that day, early indications suggest that at least one of the new Macs will be a wild success. The three new models—the Macintosh Classic, Macintosh LC, and Macintosh IIsi—were shown on campus for the first time at the MacFest held the same day that they were officially unveiled.



Macintosh Classic

The Classic looks like the original Macintosh, with a one case design, built-in nine-inch screen, and a slightly redesigned front bezel (roundish, apparently updated for the 90s). Essentially, it is a replacement for the Mac Plus and the Macintosh SE, which are slowly being discontinued. While the Classic uses the same 68000 central processing unit (CPU) as the Plus and the SE, and offers a faster optional 40 megabyte (MB) hard disk, it lacks an expansion slot. Apple claims that a user survey showed that only five percent of SE owners have used this expansion slot, so in the name of low cost Apple decided to drop this option. Inside, the Classic is mostly air due to the reduced size of the motherboard, which contributes to lower manufacturing overhead and, hence, lower cost.

Included with the Macintosh Classic, and the Macintosh LC to be described later, is a new Apple keyboard. People who try it usually find it has a fragile feel to it, and that it does not measure up to the existing Apple standard or enhanced keyboards. Fortunately, with the demise of the Mac

Plus, all three of Apple's keyboards can be used on any Macintosh model, so if you are unhappy with the included keyboard you can buy a different one from Apple or a third-party manufacturer.

The Macintosh Classic will be offered in two configurations:

1MB RAM, Apple SuperDrive (High Density 1.44MB) floppy, or 2MB RAM, Apple SuperDrive, and 40MB internal hard disk.

Keyboard and mouse are included with both configurations.

As with all other Macintosh models, other peripheral devices can be connected to the machine via the Small Computer System Interface (SCSI) port; for this reason, expansion slots are less important on a Macintosh than on other types of computers. Common peripherals include an external hard disk, scanner, and CD-ROM drive.

The Macintosh Classic should run all popular software packages, except those requiring colour. A new version of the System software, only required to support the new models, comes with the Classic. In the future, when the long-anticipated System 7.0 software finally becomes available, it will run on the Classic. However, a minimum 2MB of memory will be required and virtual memory support will not be available.

The Macintosh Classic is a sound and economic choice if you want to buy a Macintosh. Researchers, students, and home users who have mostly text-processing applications will find the Classic suitable for this purpose. Applications that require more processing power, such as

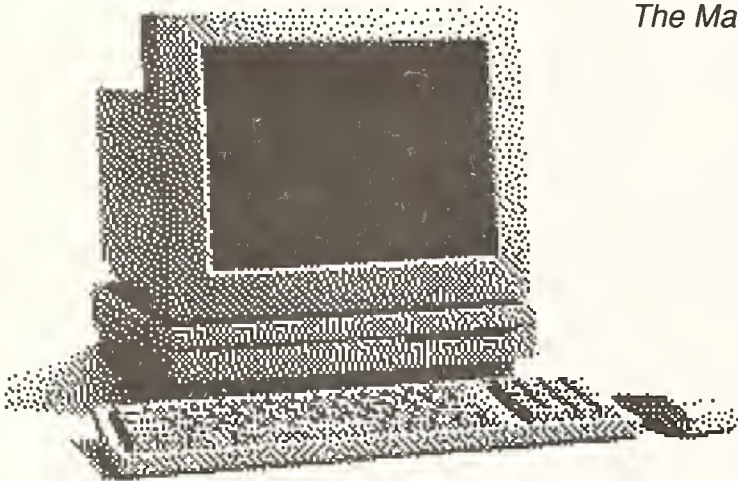
The Macintosh Classic.

Reviews

complex spreadsheet manipulation, database work, animation, and desktop publishing, will run on the Macintosh Classic, but at a considerably reduced speed.

Macintosh LC

The Macintosh LC is a curious machine. Outwardly it looks like a medium-size pizza box. Although the machine resembles the Mac II line of computers in some ways, it is neither a Macintosh II nor a compact Macintosh like the Classic or the SE. The "LC" in its name stands for Low-cost Colour; indeed, this computer offers colour but not much else.



Although it uses the same 68020 processor as the original Macintosh II introduced in 1987, the LC lacks the Macintosh II's speed and expansion options. Current Macintosh II models use the newer and faster 68030 processor, so the LC is the only model with this older processor. The math co-processor chip for fast calculation, and Paged Memory Management Unit (PMMU) for virtual memory support are not included and cannot be added. Therefore, desktop publishing, graphics applications, animation, large spreadsheets, and databases with lots of calculations will be noticeably slower on the LC.

The Macintosh LC will be offered in two configurations:

1MB RAM, Apple SuperDrive

(High Density 1.44MB) floppy, or 2MB RAM, Apple SuperDrive, and 40MB internal hard disk.

Keyboard, microphone, and mouse are included with both configurations.

The Macintosh LC, like the Macintosh IIsi described below, comes with a microphone for inputting sounds. Macintosh computers have always been capable of outputting high-quality digital sound, but in order to input sound, a separate product like Farallon's MacRecorder was necessary. New system software, HyperCard 2.0, and many third-party products like CE Software's Quick-Mail will support the built-in micro-

The Macintosh LC.

phone. HyperCard 2.0 contains a voice annotation example demonstrating this capability. Potential uses might include classroom language instruction, whereby students could record their speech exercises and compare them to answers in a native speaker's voice.

The Macintosh LC supports a variety of external monitors. Its video adapter is built in, and is capable of supporting up to 256 simultaneous colours from a choice of 16 million colours with a suitable smaller monitor. Larger monitors may require more video memory, which in the Macintosh LC is separate from main RAM memory.

As with other Macintosh models, peripheral devices can be attached to the machine through the SCSI

port. In addition, the Macintosh LC has one internal expansion slot, the Processor Direct Slot (PDS), which it is not compatible with any existing Macintosh model's slot. Apple was the first to announce a card that is compatible with this slot, the Apple IIe emulation card. With this card, the Macintosh LC could be of use to those who have an investment in Apple II ProDOS software. Using the card, the Clipboard can be used to transfer information from Apple II applications to Macintosh applications and vice versa, although the two environments cannot be run simultaneously.

The Macintosh IIsi

At first glance, the Macintosh IIsi looks very much like a low-profile Macintosh IIcx or Macintosh IIci. This is no coincidence, since the IIsi replaces the phased-out Macintosh IIcx, which was the most popular Macintosh II model. Like its predecessor, the Macintosh IIsi has to be different enough to avoid being confused with the more expensive and higher performance Macintosh IIci.

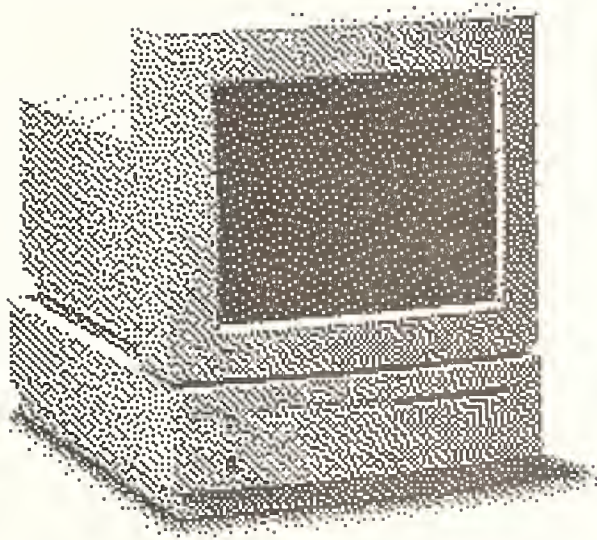
The components in the Macintosh IIsi have been redesigned to simplify assembly and keep manufacturing costs to a minimum. It can be put together in less than a minute. There are no screws inside the case, just plastic clamps that make all parts snap together neatly.

The Macintosh IIsi will be offered in two configurations:

2MB RAM, Apple SuperDrive (High Density 1.44MB), and 40MB internal hard disk, or 5MB RAM, Apple SuperDrive, and 80MB internal hard disk.

Keyboard, microphone, and mouse are included with both configurations.

Also to keep the price down, there is only one expansion slot. It can act as a Macintosh SE/30 PDS slot or a Macintosh II nuBus slot, but not both. Basically, you need a special slot adapter to add the one permissible expansion card. The type of



The Macintosh IIsx.

slot adapter you buy will determine whether your machine supports Macintosh SE/30-type expansion cards or Macintosh II-type expansion cards. You should keep in mind that space in the Macintosh IIsx case is limited, so some longer or thicker cards may not fit inside this machine.

Because a math co-processor chip is not included, the Macintosh IIsx is not a speed demon. However, if you add *any* expansion card, its speed will improve. This is because the special expansion slot adapter includes a math co-processor. Many applications, such as graphics and spreadsheets, run faster when a math co-processor is included. If you compare the Macintosh LC and the Macintosh IIsx, both of which

come with a microphone, keep in mind that applications which manipulate sound frequently utilize the math co-processor for speed.

A Paged Memory Management Unit (PMMU) chip, necessary for running AU/X (Apple's UNIX), and for using virtual memory when System 7.0 becomes available, is not included. However, you can add one.

The Macintosh IIsx does not come with a monitor, but it does have a built-in video card. Unlike the Macintosh LC, the IIsx's video card's memory comes from standard system RAM memory. The result is that when you are running graphics or desktop publishing applications with full colour, updating the screen

gets quite sluggish. If you use black and white, fewer colours, and/or a smaller screen, this problem is not as apparent. (The Macintosh IIsx's built-in video card also shares system RAM memory in this way.)

The SI appears to be a well-designed machine. It offers you a basic colour system (if a colour monitor is used) with expansion capabilities at a very reasonable price. However, for the lower price, compromises that affect performance had to be made.

For more information about these new machines, contact Dariusz Dabek at 978-6778, or send electronic mail to dabek@utcs.utoronto.ca.

Correction

In the September issue of *ComputerNews*, we did not publish the correct information about document delivery in "The Inter-Library Loan Evolution." The Document Delivery Section process approximately 90,000 requests per year, not 9,000 as stated.

ComputerNews regrets the error.

Choosing an IBM or IBM Compatible Computer

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Deciding which computer to buy can create more stress than choosing a new car. It isn't surprising, considering that you can spend your money on a computer only to find out you can't use it for what you want, whereas when you buy a car, it can probably get you where you want to go. In both cases, industry jargon and uninformed salespeople don't make the choice any easier.

To improve the chances that the computer you buy will do what you want, you need to plan for growth and consider how you will obtain service and support for the computer in the future. Service and support fall into two broad categories: basic repair service, and installation and configuration service.

The computer stopped working.

In the event your computer stops working, you have to consider some simple service issues. Something may be broken and needing replacement. What is the best way for you to get the broken component identified and replaced? How long can you do without your computer while it is being repaired? The normal channels for this type of activity are your dealer, the manufacturer, or third-party service organizations.

I installed this "new thing," then the computer stopped working.

Problems arising from the installation of a new piece of software or hardware are frequently complex. Usually, the difficulty is one of

configuration that can be solved by setting switches correctly or using the correct values in a setup file. But how are you going to find the person who knows this information? Occasionally, there is a genuine compatibility problem between pieces of hardware. When this happens, you are dependent on the manufacturer to assign engineering resources for diagnosing and fixing the problem.

Planning for Growth

The easiest way that we know to plan for future growth is to purchase a computer that uses the 80386 family of Central Processing Unit (CPU) chips. If the computer you buy is not using this technology, there are several important software advances (described below) of which you will not be able to take advantage.

Multi-Tasking MS-DOS: Programs like DESQview and VM386 take advantage of a 80386 with additional memory so that several different programs can be running simultaneously.

OS/2: Versions of MS-DOS programs that run under OS/2 are currently available or shortly to be released: Lotus 1-2-3, SAS, Page-Maker, and Paradox 3, to name a few. On a 80386 machine, the OS/2 versions run faster and let you work with greater amounts of information.

Windows 3.0: Most of the major companies are preparing, or have prepared, Windows versions of their programs, including word-processing, spreadsheet, database management, graphic design, and desktop publishing applications. Only 80386 computers let Windows 3.0 perform to its maximum capacity.

Networks: Memory managers like 386/MAX and QEMM can be used with an 80386 machine to optimize memory usage. This improves the performance and capacity of programs working in a local area network environment.

While you may be convinced that you "only want to do word-processing," the odds are that within the next three years you will find yourself needing to make use of programs that require or benefit substantially from a 80386 CPU. An exception to this would be purchasing a laptop or notebook computer where size and weight are more important considerations than speed or future compatibility.

Within the 80386 family of computers, there is a considerable range of both performance and cost. The low end is occupied by machines that use the 80386SX CPU running at a speed of 16 megahertz (MHz). The high-end machines use either a 80386 CPU running at 33MHz or the newer 80486 CPU.

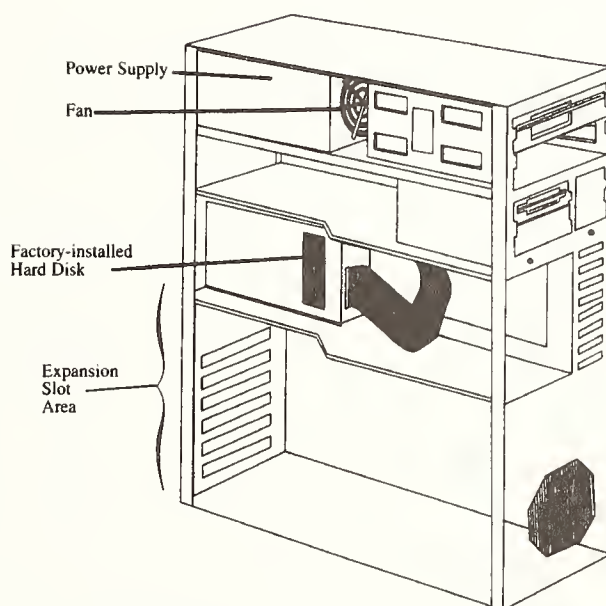
Commodore PC-60 III

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The PC-60 III computer is a tower-style design 24.5 inches high, 10.5 inches wide, and 19 inches deep. These dimensions raise the question: "Can a computer still be called personal if it is big enough to hide behind?" While we don't intend to answer that question now, the performance, size, and cost of the PC-60 III suggest that it is intended for tasks more demanding than simple word-processing. It features a 25 megahertz (MHz) 80386 microprocessor, using a cached 32-bit memory which can be expanded to 16 megabytes (MB). It is this combination of microprocessor speed and memory that gives the computer its power.

Before taking the machine apart, we reviewed the accompanying documentation. Commodore publishes their own manuals for MS-DOS SHELL, MS-DOS 4.01 User's Guide, MS-DOS User's Reference, and GW-Basic. While these books provide the information necessary for installing and using the MS-DOS operating system on the PC-60 III, the novice will have difficulty understanding them.

The PC-60 III Operations Guide offers a step-by-step guide to installing and using the computer. In addition to the simple language, there are many pictures showing where things go. About half the book is appendices that cover technical details such as error



The towering computer.

messages, memory configuration, video modes, and jumper locations on the circuit board, including pin-out diagrams for the connectors.

Inside Story

Taking the computer apart is easy. A plastic front bezel snaps off, revealing two metal side panels, each panel attached with four screws. Inside the chassis there is space for two full-height 5.25 inch devices. There are also two half-height 5.25 inch bays and two half-height 3.5 inch bays that are accessible through the front bezel. Circuitry for the floppy disk, hard disk, Video Graphics Array (VGA) display, serial port, mouse port, and parallel printer port are located on the motherboard.

The motherboard also features nine 16-bit slots for adapter cards. Two of these slots have an additional 32-bit socket for use with the special 32-bit memory cards used to expand the computer's memory.

Our evaluation unit came with two megabytes (MB) of memory, an 83MB hard disk, a 5.25 inch diskette drive, a 3.5 inch diskette drive, a colour monitor, and a keyboard. The 1432 monitor features controls for brightness, contrast, and horizontal shift. The keyboard is an 101-key "enhanced" style with the function keys at the top. MS-DOS, version 4.01, is installed on the hard disk.

System Setup

The PC-60 III uses a Read Only Memory (ROM) based setup utility. With the setup in ROM, you don't have to worry about finding a copy of the configuration program, an advantage if your hard disk or floppy disk has stopped working. The utility itself uses a simple "fill in the blanks" approach to defining the various system parameters. Some parameters, such as time and date, are straightforward. Other options like drive types and memory management options are inherently technical and require some expertise. The setup utility helps with some of the technical details by providing a list of default values for drive types and memory areas.

Simple Benchmarks

Developing useful benchmarks is an area of controversy these days, particularly when evaluating high-end machines like the PC-60 III.

Reviews

There are so many factors to take into account, such as memory size and type, disk speed, and numerical co-processor. Different programs make different demands on these resources. In spite of this, we could not help running a few simple test programs. Norton Utilities System Information (SI) gave a Computing Index of 29.4 and a Disk Index of 6.1. Coretest, a disk benchmarking program, reported that the hard disk had a transfer rate of 811.4 kilobytes (KB) per second and a 20.2 milli-second access time. If you have concerns about performance, we recommend that you call us to talk about your specific application.

General Applications

The PC-60 III appears to be a very compatible machine. We experienced no difficulties running any of our software. WordPerfect 5.0 and 5.1, Norton Utilities, Microsoft Word for Windows, DESQview, LapLink, ProComm, and dBASE IV were all used without difficulty.

Earlier we mentioned that the PC-60 III was more than you needed for simple word-processing. While this may be the case today, the trend in the industry is towards word processors that use a graphical/mouse interface with the capability to display and print multiple proportional fonts and pictures. The computing power needed to do all these tricks is quite considerable. As programs become more dependent on the graphical interface, the capabilities of a computer like the PC-60 III will become the norm.

In order to gain an appreciation of the PC-60 III's capability to run more advanced software, we tried some of the following applications:

PageMaker 3.0

We used PageMaker to work on a document that was a mixture of text and graphics. The computer's responsiveness was enjoyable. As

mentioned earlier, the VGA adapter is built into the motherboard of the computer. While the VGA format is convenient for most graphical software, intensive desktop publishing and computer aided design (CAD) usually require the use of a special high-resolution graphics board and monitor. If you are planning on installing a high-resolution graphics card, investigate possible compatibility problems before purchasing the machine.

NCSA Telnet

Telnet is a program that permits an MS-DOS compatible computer to use an Ethernet network to gain access to a mini or mainframe computer. The program offers emulation of a VT-100 type terminal for use with UNIX hosts, and 3270 type emulation for use with IBM hosts. We successfully logged into both a SUN host and an IBM host.

SAS

For the individual planning on crunching a lot of numbers, the PC-60 III looks like a good choice. We used the SAS utility, TESTBASE, version 6.03, to test both compati-

bility and performance. Running TESTBASE with 1024 kilobytes of expanded memory resulted in the successful completion of the utility in 9 minutes and 40 seconds. Turning the expanded memory off lengthened the process to 14 minutes and 20 seconds. SAS is one application that really benefits from the addition of a co-processor, and there is a socket for a 25 Megahertz 80387 co-processor on the motherboard.

Conclusion

The PC-60 III is a well-designed and constructed computer. The unit comes configured with equipment that is balanced in its ability to deliver good performance with today's applications. There is ample room for expansion of mass storage peripherals such as disk and tape drives, adapter cards, and memory. The PC-60 III also offers a high-performance upgrade path, should users choose to move to either a UNIX/XENIX or OS/2 environment when those markets mature. The machine's memory cache, 32-bit memory bus, and a fast hard disk provide an economical workstation while maintaining MS-DOS compatibility.

Help Available

The Information Centre has a Zenith 386/33 and a Commodore PC-60 III on loan. You are welcome to make an appointment to see them. We also invite you to take advantage of our consulting services (available without charge to faculty, staff, and graduate students) for help with planning your computer purchases. Call David Sutherland at 978-5426 for an appointment.

The Zenith 386/33

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It is worth looking at high-end computers like the Zenith 386/33 to see the feature set that personal computers are moving towards. As this type of machine proliferates, more software will be written to take advantage of the features. In turn, this new software will not run properly on computers built with the older CPUs.

The main features that distinguish a high-end computer like the Zenith 80386/33 from middle-of-the-road machines are:

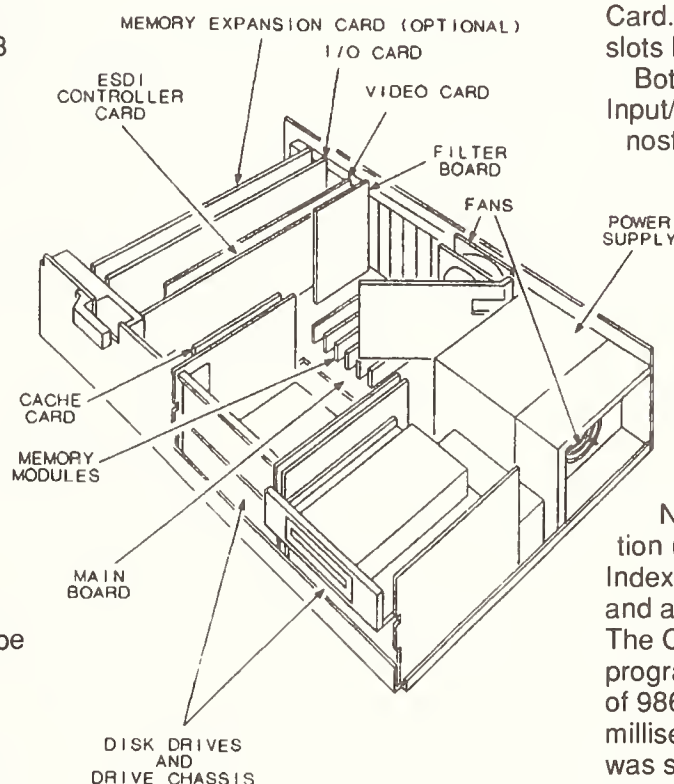
- memory caching
- on-board memory expansion capabilities
- large storage capacity (number of hard disks and tape drives and their size)
- high-resolution graphics.

Our evaluation machine was equipped with a Video Graphics Array (VGA) card, VGA monitor, disk controller card, Input/Output card, two megabytes (MB) of memory, memory cache controller, and 150MB hard disk.

Under the Hood

With the 386/33, Zenith continues their tradition of superior mechanical engineering. The chassis and lid are metal construction, the lid being attached with six screws. Inside the box, there is a motherboard, power supply, and space for six half-height 5.25 inch disks or tape drives.

The motherboard is of modern design and makes extensive use of surface mounting circuitry. The 33 megahertz (MHz) 80386 CPU is located on the motherboard, along



Inside the Zenith 386/33.

with a socket for a math co-processor (Intel or Wietek). Memory can be expanded to 16MB using 1MB Single In-line Memory Modules (SIMMs) or to 32MB using 4MB SIMMs on the motherboard. The optional memory cache controller plugs into a socket on the motherboard as well.

Industry-standard adapter cards can be plugged into any one of seven 16-bit slots. Four of these slots have an additional 32-bit extension that can be used by proprietary 32-bit adapters developed by Zenith, such as the Input/Output Card or Memory Expansion

Card. Our configuration had four slots left for expansion.

Both the motherboard and the Input/Output board feature diagnostic Light Emitting Diodes (LEDs) that provide status information on the power supply voltages, co-processor, memory, disk drive, and other devices.

Out for a Spin

We ran two simple benchmark programs. The Norton Utilities System Information (SI) program gave a Computing Index of 40.6, a Disk Index of 4.3, and a Performance Index of 28.5. The Coretest hard disk evaluation program reported a disk transfer time of 986.6 kilobytes/second and 15.9 milliseconds average seek time. I was surprised when Norton Utilities SI rated the hard disk performance at only four times that of an XT hard disk. The figures that Coretest offers show the hard disk to be performing very quickly. The discrepancy between these numbers demonstrates the problems of creating meaningful benchmarks as personal computers become more powerful.

We installed Windows 3.0 and Windows 286, PageMaker, Microsoft Word for Windows, WordPerfect 5.1, dBASE IV, Paradox 3, Lotus 1-2-3 (release 3), Autodesk Animator, and SAS. With this set of programs, we can experience some of what personal computing will be like in the 90's.

Both versions of Windows worked well. With Windows 3.0 we were able to start up several programs (WordPerfect and dBASE for

Reviews

example) and move between them. The speed of the CPU and hard disk combined made using PageMaker a very quick and efficient process. This speed also helped Microsoft Word for Windows, a notoriously slow program, perform at a comfortable rate.

On the numerical side of things, the SAS compatibility testing suite, TESTBASE, ran successfully, taking 12 minutes and 33 seconds to complete using Expanded Memory System (EMS) memory and 20 minutes and 52 seconds without using EMS. Lotus 1-2-3, release 3, installed and operated without difficulty.

An application was developed in Paradox 3 using the Zenith 386/33. Paradox, like many databases, makes extensive use of the hard disk, and we found the computer to perform very quickly in this situation.

We installed a 3Com Ethernet adapter and used it to access both a central file server running Novell 2.15 and a UNIX host computer using the Telnet program. Serial communication using the U of T version of ProComm and the file transfer program LapLink worked correctly.

Documentation

The comprehensive documentation that accompanies the unit consists of ten manuals. The hardware manuals are terse, technical, and thorough, with numerous diagrams and tables. Zenith prepares their own version of the MS-DOS 3.3 and WINDOWS 2.1 manuals containing all the standard information you would expect to find.

The Quick Reference guides to MS-DOS and Windows are speedy ways to look up information about commands and procedures.

Closing

We enjoyed working with the Zenith 386/33. Working on an 8MHz 80286 with sophisticated programs like PageMaker, Paradox 3, and dBASE IV became painfully slow in comparison.

Zenith is known as a manufacturer of reliable computers. The company is part of a large trans-national conglomerate and can be expected to continue supporting their products. Naturally, there is a premium to be paid for security, and some people feel more comfortable if they pay the premium.

Fast CPU and Memory Caching

Memory caching is used to maximize the performance of a computer's central processing unit (CPU) and minimize the cost of memory. Memory caching has been used for years in the mainframe and minicomputer worlds. As microprocessors have become faster, memory caching technology has been introduced into personal computer designs.

Microprocessors are the "brains" of a personal computer. All things being equal (though, in computers things are never equal), the clock rate of a CPU determines how fast the work gets done. The CPU's clock is like a musician's metronome, synchronizing the performance with every beat. In the case of the computer, the tick of the clock lets the electricity flow through the circuit. The clock rate is usually measured in megahertz (MHz), the idea being that the more megahertz you have, the faster you go. We would expect a 33MHz CPU to be about twice as fast as a 16MHz CPU.

Unfortunately, CPUs need to work with other components like keyboards, video displays, and disk drives. Since these other components are not as quick as the CPU, the CPU can spend a lot of time waiting – waiting for information to be found on a hard disk, waiting for information to be sent through a modem. With the introduction of CPUs that run faster than 20MHz, the typical memory chips used in personal computers become a bottleneck; the electricity can't flow through these memory chips fast enough. Since programs are

constantly using memory, the CPU is constantly forced to wait. This waiting for memory minimizes most of the performance gains that a faster CPU provides. The obvious choice is to use faster memory in the computer, but faster memory is expensive. A memory cache is an engineering compromise that works very well in delivering improved performance without substantially raising costs.

A memory cache is a small amount (between 32 and 128 kilobytes) of fast memory that can keep up with the CPU. The key to making the whole thing work is a memory cache controller, which monitors the CPU's requests for information from memory.

The first time the CPU issues a memory request, the cache is empty. The CPU must wait until the information is found in the slower main memory. The cache controller monitors this process and places a copy of the information into the fast cache memory area. The next time the CPU issues the same memory request, the cache can provide the information without the wait. Very quickly the cache becomes full of the data that the CPU needs. The cache controller keeps track of the information requests and uses the limited space in the cache to keep the most requested items.

The result is that between 70% to 90% of the CPU's requests for data will be found in the cache. This gives the computer an effective performance improvement without the expense of installing higher speed main memory.

Software

PageMaker 4.0

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PageMaker 4.0 is a major upgrade to the Macintosh version of one of the most popular desktop publishing programs. PageMaker is a program that allows you to produce complex documents, incorporating both text and graphics. You can create course bulletins, pamphlets, posters—you are limited only by your imagination. Major changes in PageMaker 4.0 include the installation process, the story editor, and the spell checker.

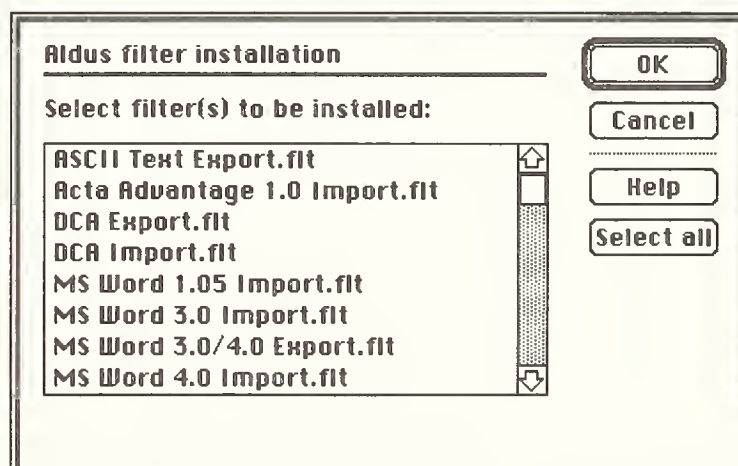
Installation

When you purchase the program, you receive five installation diskettes. These diskettes contain all the files you will need to run PageMaker, plus some templates that allow you to design documents more easily. To install the program, turn off MultiFinder if you are running it, and turn off any virus protection programs you may have installed. Virus protection programs can misinterpret installation as the invasion of a virus, and your installa-

tion will fail. Lastly, make sure you have at least five megabytes (MB) of space available on your hard disk. PageMaker 4.0 now consumes a monstrous 5MB of hard-disk storage space when you choose to install all the available features.

Before you try to install the program, make backup copies of all the diskettes; you will use these copies for installation. To install the program, pop the diskette labelled "Disk 1" into your floppy disk drive. This diskette contains a new installation utility that decompresses the files on the diskettes as the program is installed onto your hard disk. The installer lets you customize PageMaker to suit your work environment; thus you can choose only the required translation filters (for word-processing files), dictionaries (for spell-checking), and printer descriptions you want. When you double-click the Installer icon to set the installation process in motion, you will receive a series of prompts telling you what to do next, e.g., "Insert Disk 2," "Select Dictionaries to be installed," "Select Filter(s) to be

This panel allows you to select import and export filters during installation.

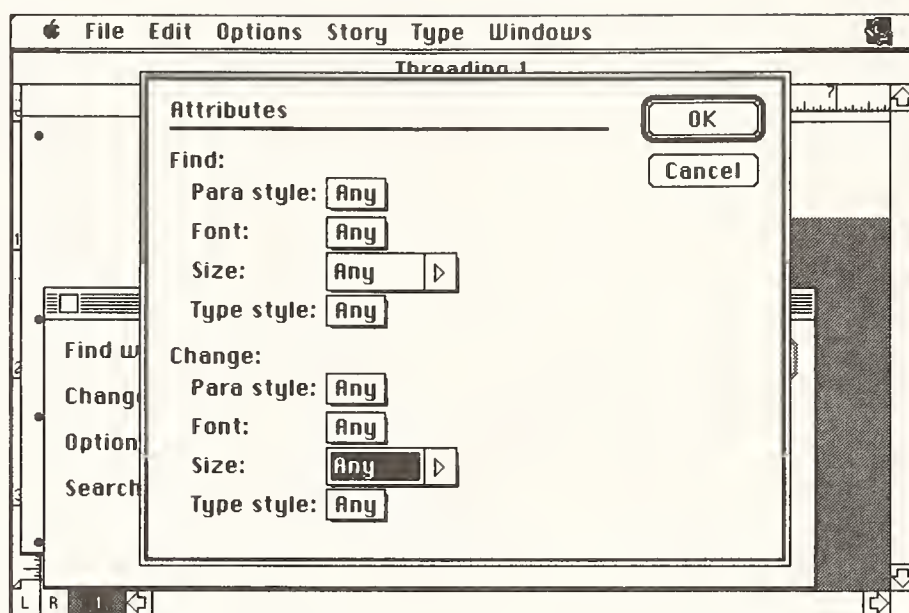


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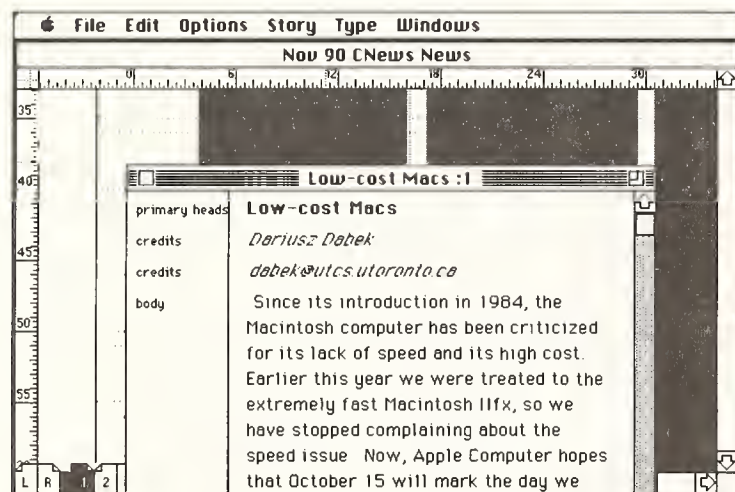
installed," and so on. If you follow these instructions exactly, you should have no trouble installing PageMaker.

Installation creates new folders on your Mac and puts certain files into these folders. Specifically, it creates a folder called "Aldus Folder" that stores all the utility files in the Macintosh System Folder. If the installation is successful, you will have all the files in the correct spot, and will not need to worry about printer description (APD) files and dictionaries.

Because this installation process is unlike the way most Macintosh programs are loaded, you should read the installation portion of the *Getting Started* manual before you start.



The Change Attributes dialogue box.

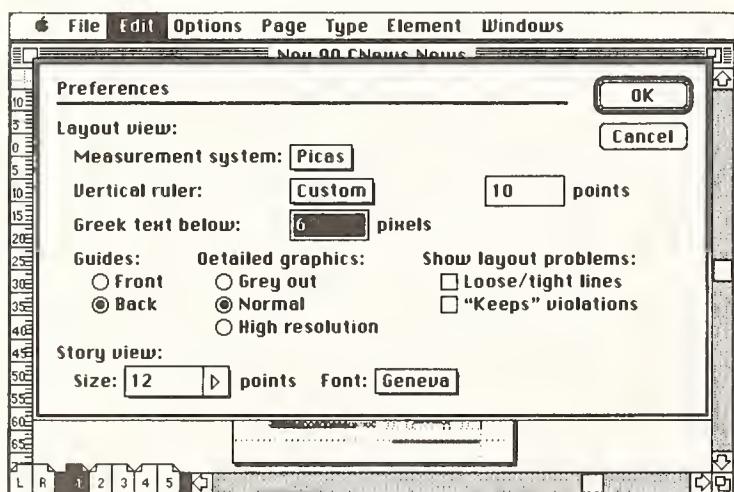


PageMaker's Story window shows style names on the left and text on the right.

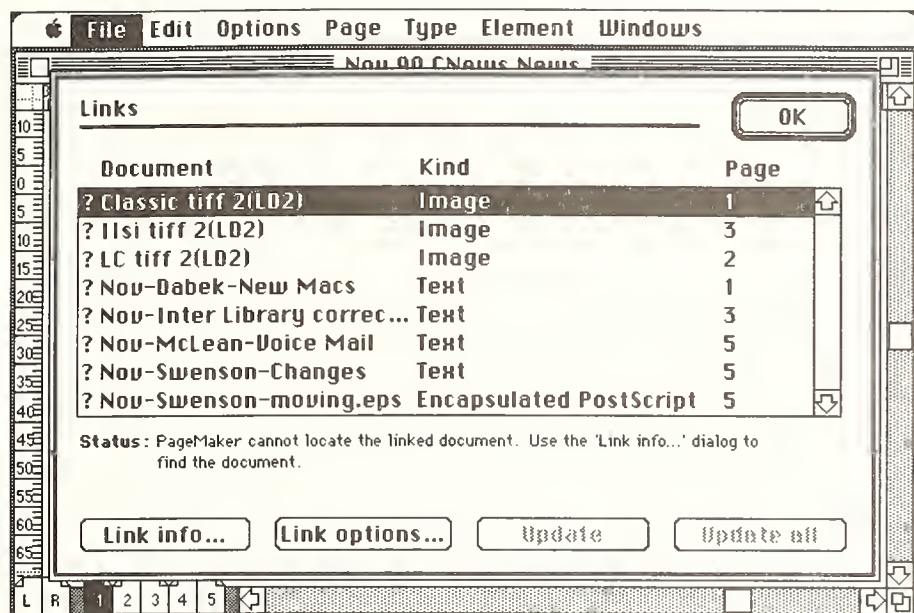
Story Editor

The new story editor is one of PageMaker's most welcome new features. The story editor lets you edit stories that you have created in PageMaker or have imported into your document from a word-processing file. Rather than go blind trying to edit stories that are laid out on complex pages in small type, you can now select a text block and ask to edit the story in story view. The text you see in this window is much more readable. In the Preferences option under the Edit menu, you can choose the font and the font size you wish to see in story view. The font you choose to use in story view does not affect the fonts you have chosen to use in the layout view of your document.

The story window has two columns, one which displays the text, plus a parallel column that shows the names of the styles corresponding to each paragraph in the story. This makes it easy to check styles throughout a story to ensure consistency, and also to apply styles to a story. (If you work with style sheets, you know what a tedious task it is to



Use the Preferences panel to choose the font and font size for story view.



Using the Links feature, you can update external graphics and text files. If PageMaker cannot find the external file, it displays a question mark to the left of the filename.

apply styles to text in version 3.0.) In the story window, you can select the paragraph(s) to which you want to apply a style, and then select the desired style in your style palette. You won't see all the formatting changes while in story view, but you will as soon as you return to layout view. The advantage of using this method is that it eliminates the time you have to wait for the screen to redraw every time you make a change in layout view. (If you don't work with style sheets—collections of styling and formatting information—but would like to learn how, call Geoffrey Rockwell or Harriet Ji.)

You can import text directly into a story while you are using the story editor. This means you can add extra text to an existing story easily, without having to cut and paste. You can also export a story in a variety of word-processing file formats.

Changing and Spell Checking

Another useful addition to PageMaker is the ability to search for and replace text. You do this using the story editor, but you are not limited to a single story. You can conduct a search and replace using only the

story you are looking at in the story editor, or all the stories in your PageMaker file. What is intriguing is PageMaker's ability to search and replace attributes; for instance, you can search for all instances of an underlined title, The Republic, and simply change the style of the title to italic, *The Republic*.

Related to this is the ability to spell check a document in both French and English. With the Canadian version come the French and English (as opposed to American) dictionaries. You can "tag" paragraphs as being in either of these two languages, so that when a bilingual story is spell checked, the appropriate dictionary is used for the appropriate paragraph. Your French text gets checked with the French dictionary and the English text with the Canadian English dictionary. The French dictionary is sensitive to accents, e.g., it will suggest "être" for "etre".

If you regularly use certain words that do not appear in PageMaker's dictionary, you can add them to it. The program allows you to specify case, as well as define preferred hyphenation.

PageMaker comes with a glossy brochure that lists other dictionaries for sale. These include most of the European languages, like Italian,

German, Dutch, and Spanish. Medical and legal dictionaries are also available.

Linking

When you import a new text or graphics file into PageMaker, PageMaker forges a "link" between the external file and the corresponding text or graphic in your document. If you make any changes to an external file, you can update your PageMaker file easily. Using the LINK OPTIONS feature under the Element menu, you can set up your PageMaker file so that it performs updates automatically upon opening, or you can ask it to warn you whenever changes have been made. If you choose the latter method, you have to issue an UPDATE command in order to see the changes in the most recent versions of your external files reflected in the corresponding text and graphics in your PageMaker document.

When you select the LINKS command under the File menu, PageMaker brings up a window showing you the current status of each file in your document. An icon appearing beside the filename will tell you whether the external file has been modified and is waiting to be

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updated, whether both the external and PageMaker versions have been modified, or if the link has been broken and PageMaker can no longer find the external file. If you move a linked file from its original folder, PageMaker will lose track of it and you will have to create a new link. Fortunately, this is easy to do.

More Goodies

It would occupy too much space if we were to examine the rest of PageMaker's new features in detail, so here is a selection of some of the new features that we like.

Compressing Graphics Files: When you import Tag Image File Format (TIFF) files into your PageMaker document, they occupy a lot of space. Now you can compress them. After you have issued the PLACE command, select the file you want to place. Then, holding down the <Command>, <Option>, and <Shift> keys, use your pointer to click OK. When you do this, PageMaker creates a compressed version of the TIFF file, and uses the new version in your document. The compressed version of the TIFF file retains the name of the original, but has an extension added to the filename to let you know that this file is compressed.

Rotating Text: Good news! You can now have rotated text in PageMaker without having to create it in a graphics program first and then import it as a graphics file. To do this, select the text you want to

rotate using the pointer tool. When PageMaker rotates text, it rotates the entire text block, not a selection of text within it. Then, select TEXT ROTATION under the Element menu. You will see a panel showing the letter A rotated in four 90-degree increments. Click the icon that displays the rotation you want, and the program will do the rest. You can edit rotated text, but only through the story editor.

Inline Graphics: Occasionally you may have a piece of artwork that you would like to keep with specific text. In version 4.0, you can place graphics right in the text block. Click an insertion point where you would like the graphic to appear, use the PLACE command to enable you to select the graphic you want, select AS INLINE GRAPHIC in the PLACE window, and click OK. The graphic will appear in the text block and will move with the text. Things to watch out for: If you have defined a specific leading value for your text, you may find that the text covers your picture. Select your graphic with the text tool and choose autoleading, and the problem should be corrected. The *Reference Manual* gives clear instructions to help you position your inline graphic to your satisfaction.

Paragraph Rules: Using the Rules feature in the Paragraph specifications dialog box, you can place lines above or below your text. You can choose from several line weights, specify how far above or below the baseline you want the line to appear, select colour, and so on. It takes a

bit of experimentation to get the hang of this, but the manual will help you along.

Converting Version 3.0 Documents: Unlike many other programs, PageMaker 4.0 does not automatically convert your version 3.0 documents to version 4.0. The reason for this is that PageMaker 4.0 has more precise letter- and line-spacing controls, and this can cause text laid out in version 3.0 documents to move around when they are converted to version 4.0 format. If you wish, you can open up a copy of a version 3.0 document by using the OPEN command when version 4.0 is running. If you want to retain the version 3.0 format of some of your documents and continue to work with them in that format, you will have to keep both versions of PageMaker on your computer.

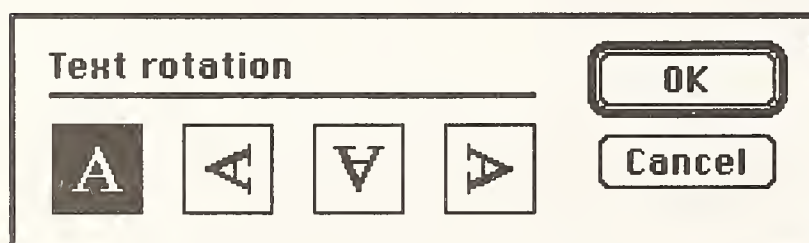
Conclusions

The additions to PageMaker are well-designed and well-implemented. PageMaker has always been a good clean tool for laying out complex documents. The new features make it better at handling text. The only drawbacks seem to be the size of PageMaker, its utilities, and its speed. It has become a big and slow program that needs a fast Mac with a large hard drive.

PageMaker 4.0 is available only on the Macintosh at the moment. Aldus has promised an IBM PC version in the spring of next year. To upgrade from version 3.0 costs US\$150. The list price for a first-time purchase is US\$795, but many retailers charge less. We called two shops in Toronto, and were quoted CDN\$784 and CDN\$695 respectively. (You also can save money by purchasing through mail order.) Educational versions are available for even less; contact us for the latest word on these versions.

For more information or a demonstration, contact Geoffrey Rockwell at 978-4548 or Harriet Ji at 978-6050.

When you select your text block and click on a rotated A, your text block will be rotated accordingly. This feature works only with text blocks that are not linked to other text blocks.

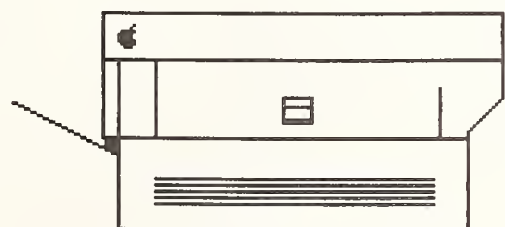


Nota Bene Support Reduced to Class C

For a number of years, UTCS has supported the word processing package "Nota Bene" at a Class A level, principally by providing advising support to Nota Bene users, and by offering a special purchase plan. We originally chose Nota Bene as a product to support because we felt that its special academically-oriented features would be valuable to many users at the University of Toronto.

Over the years, however, the user community for Nota Bene has remained relatively small, and many (although not all) the features provided by Nota Bene are now available in other word processors. For this and various other reasons, UTCS has decided to reduce the support for Nota Bene to Class C. Explanations of support classes are found on page 44.

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Double Helix 3.0: A Macintosh Database for Academic Use

Martha Parrott
parrott@utcs.utoronto.ca

Double Helix 3.0 comes from Odesta Corporation, whose marketing material calls this product "the data management system for people who don't think in code." After using this package for a little while, I have to say that I'm impressed. I had thought of Helix as a non-programmable database, but that's not the case: it just doesn't have all those verbal commands with finicky syntax typical of many database programming languages. You can build about as complex and user-friendly an application as you wish, either for yourself or for someone else. The only trick is the same one that applies to all computer programs: it doesn't think for you, it just does the work. You still have to think through and organize your application, and you do have to learn the program's way of thinking. Also, because it does not yet support Structured Query Language and the kind of networking needed for mainframe access, Double Helix is not recommended for administrative applications within the University. For strictly academic applications, however, it may be a suitable choice.

Helix was born and grew up on the Macintosh, so its interface is made up largely of objects represented by icons. An application or project is called a Collection. Each

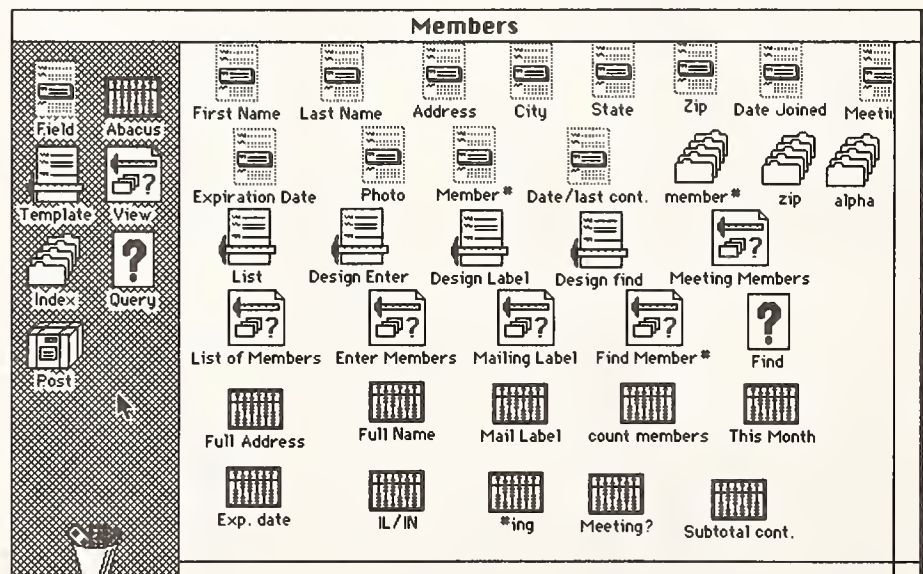
Collection comprises one or more Relations, plus optional objects such as Sequences (similar to macros) or Users (customized user access to the Collection). In this review, I will deal primarily with what goes on in and between Relations.

Double Helix is available in a single-user and multiuser versions. My experience has been with the single-user version.

It's not an affair; it's just a relationship

Relations can contain a large number of objects: Fields, Views, Templates (these govern the appearance of a View), Indexes, Abacuses (for any kind of manipulation), Queries, and Postings (for, among other things, data distribution to other Relations). These objects are created simply by dragging an appropriate icon into the work area of the Relation window (see Figure 1).

Figure 1



UTCS is publishing this review for the interest of individuals and academics only.

Administrative staff should be warned that standards for database packages on microcomputers have yet to be established, and hence purchasing these packages for department-wide use cannot be recommended.

Field types are Text, Number, Flag, Date/Time, and Picture. Text and number fields are, for practical purposes, unlimited in length (32500 characters). More importantly, their size is dynamic; that is, in fields whose data varies in length, Helix uses only as much space as is necessary for the data in each field in each record. Field attributes include Format, Validation, and Inert. Validation can be based on the field being defined or on a variety of other options; you can put in your own error message to be displayed when invalid data is entered in the field. An inert field is used only to enter temporary data needed for some other purpose, such as the beginning or ending of a date range in a query.

Data in, data out

Like some other Mac databases (e.g., 4th Dimension), you have to create a View screen to enter, see, edit, or print your data. It can be the simple default screen if you wish, but you must drag a View icon into the window. Customized screens are created with Templates. Templates don't have as many of the Mac graphics tools as some other Mac databases, but you can import graphics through the Mac Clipboard or Scrapbook, and of course you have a choice of type fonts and styles. Deleting objects in a Template is not as easy as it might be, but at least you are less likely to do it accidentally.

You can build links between Views, so that clicking on a record in a listing View, for example, brings up the same record in a data-entry or edit View. You can also use one Template as part of another.

Views have three possible windows. A View can be associated with any Template in the Relation simply by opening the View and choosing from the Templates available in the View's Selection window. You can also choose a particular index or query at the same time. Another View window allows

you to see the actual form, with or without your data. In the third window, you can select a particular Posting and determine when it will happen (more about Postings later). All of these choices remain in effect until you change them, so the next time you open the View, you find it exactly as you left it.

In any data input View, you can enter a new record, and edit or delete the first, last, next, or previous record. Asking for all records shows records in a simple tabular form. You can also do Quick Queries (using query by example).

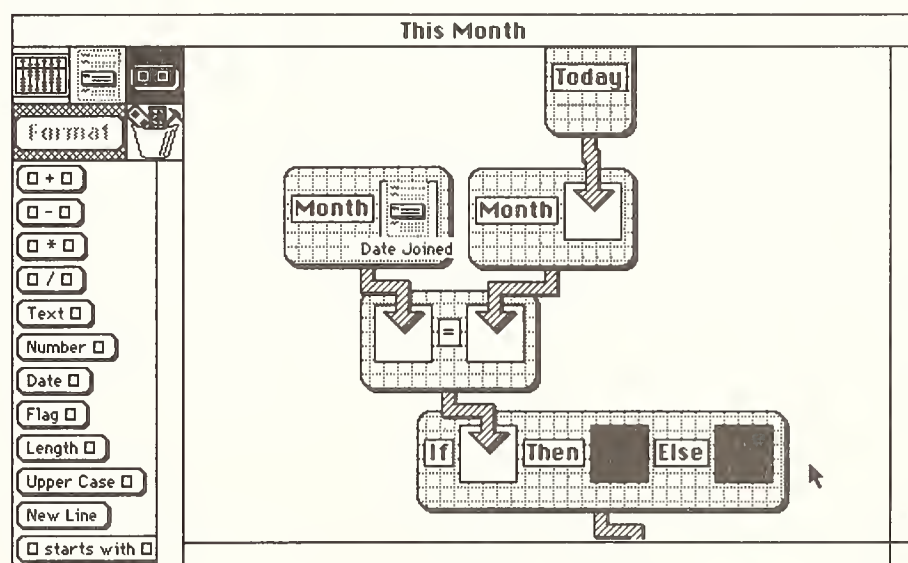
The heart of the matter

The whole point of a database package is what you can do with the data you enter. Otherwise, you might as well have a card file. Helix does data manipulation in a number of ways. The Abacus is the most frequently used tool. Calculations, lookups, string manipulation, queries, and comparisons may all be done with this tool. The Abacus comes with a large selection of "Tiles" representing various functions and actions. Each tile has one or more "black holes" that take input from a Field, a Relation, another Abacus, another Tile, or data that you type in. Each Abacus comes with an arrow that you can drag into the black hole of another Abacus if necessary (see Figure 2).

The Abacus is essentially a graphical representation of the kind of programming languages found in other database packages. These representations can become pretty complex and may seem daunting at first sight, at least to those of us used to verbal programming. However, the documentation shows many helpful examples, and I soon got the hang of it. My only complaint about the Abacus is that the Tiles are available only by scrolling through a list; there's no quick way to get to the Tile you want. However, since this problem stems in part from the generous number of Tiles to choose from, it's difficult to complain very loudly.

Another way to organize data is through Indexes. These can have nested Fields, each sorted in ascending or descending order. You can have up to 128 indexes in any one Relation (assuming you really need that many), and although only one can be active at one time, all may be automatically updated. Since automatic updating slows down performance, you can in

Figure 2



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some circumstances opt to put off updating.

Posting is a wonderful tool for working with data. You can use it to put data collected or calculated in one Relation into the appropriate Field in another Relation or even into a Field in another record in the same Relation. You can also do global changes (e.g., when the sales tax changes, you can post it to all the records affected). Another feature is the Auto Open form. This is useful if, for example, you are keeping supplementary information in a Relation linked to a Relation with the primary information. If you are posting supplementary information to a record that doesn't exist in the primary Relation, you can arrange for the appropriate data-entry View to pop up so you can create the primary record on the fly.

Double Helix provides three ways to search for data. Quick Query is the most limited, allowing only one criterion at a time. The Query icon allows you to specify values falling within a range. The Abacus query is by far the most powerful and flexible search tool, allowing complex conditions and Boolean (AND, OR, NOT) operators.

Coming and Going

Importing and exporting data is easy and works well. Helix can accept or create DIF, SYLK, or ASCII files (<Tab> delimited is safest for importing). Anyone who has ever imported data into other database packages will appreciate Helix's dynamic fields—no need to figure out field sizes here. Limitations are ones you might expect: you can't export a picture field and you can't import into an Abacus.

Safety

Double Helix offers various ways to protect your data and your application. I've already mentioned Field validation, and you can also protect against duplicate records. Other protection lies in utilities that can sometimes recover damaged Collections and data that might have been lost in a system crash. Helix also has an automatic save feature.

Documentation

Other than error messages, Double Helix has no online help (although you can create your own if you are designing applications for other people). It does, however, have excellent printed documentation.

A copy of Helix comes with one of several short tutorials from the Quick Start Series. Each of these is based on a particular Collection and gives enough information for you to get started with a reasonably straightforward application. The User's Guide also takes a tutorial approach but is much more thorough. It follows one complex Collection in detail and is arranged with step-by-step instructions on the right hand page and related general information and tips on the left hand. A good introduction to database concepts is also provided. Finally, the Reference Manual is intended to supplement the User's Guide with very detailed information. It is arranged in chapters, each dealing with a particular kind of object (e.g., icons, menus, windows, Abacus tiles,

views, etc.) or theme (e.g., printing), and each having its own table of contents. A chapter on Help responds to questions or problems that often arise, and another chapter offers suggestions on designing and optimizing your application. All of these manuals are written in a clear, readable style, and the two main ones have good indexes.

Free technical support and an online bulletin board are also available to registered users, although you do have to pay for the call.

Overall

Double Helix is a powerful program, well thought out and rich in features. This means that it is complex and not to be entirely mastered in a couple of hours. Once you've spent some time with the tutorials, however, you can probably set up an average application in a couple of hours. It's also easy to customize applications for specific users, setting passwords, limiting the type of access to certain Views, changing the menu bar, and creating your own error messages.

Double Helix runs on any Macintosh with a hard disk. The educational price for the full package is US\$357, but for US\$10 you can get a trial version, which includes the complete program file (30-record limit) and one of the Quick Start Series tutorials. Odesta Corporation may be reached at (800) 334-6041.

Adobe Type Manager for Windows

Windows 3.0 was a giant step forward for the graphical user interface on DOS-based computers. Programs like Word For Windows, Ami, and PageMaker brought What You See Is What You Get (WYSIWYG) capabilities to the PC platform in an environment that could finally take advantage of all your machine resources (i.e., memory beyond 640 kilobytes and multitasking). Or did they?

When you see the accompanying photos of Adobe Type Manager (ATM) in action under Windows 3.0, you will realize that only now do you have a real WYSIWYG environment for text!

You can see from the two screen images that the ATM screens are more accurate and easier to read. In *Figure 1*, the first two characters of the second word are actually in the italic font. Without ATM, they appear to overlap and are very ragged. In *Figure 2*, with ATM, they are positioned properly and look as smooth as is possible for the screen. The scans of the printed pages tell an even more drastic story. The document was printed once on a PostScript laser printer and four times on a low-cost dot matrix printer: high resolution (240x144

dpi) with ATM, high resolution (120x72 dpi) with ATM, low resolution (120x72 dpi) without ATM. With the PostScript laser output being the reference, you can see that the pages printed with ATM are accurate dot matrix representations of the laser output, and that they do not change as the output resolution changes. On the pages printed without ATM, you can see that not only are the italic characters overlapping as we saw on the screen, but the output changed drastically when we changed the resolution. (See figures on page 18.)

Performance was surprisingly good using ATM. The testing was done on a 16 megahertz (MHz) 386SX Commodore 50-II with five megabyte (MB) Random Access Memory (RAM). There was a slight delay when you typed the first character after choosing the font size. During this time, ATM converts the PostScript scalable font on disk into a bitmap representation for the screen. After the initial delay, things are quick. Each time you change fonts you will see this delay, but there is also a caching scheme to keep recently-used fonts available. The cache size is easily changed



Figure 1 shows Windows 3.0 without Type Manager.



Figure 2 shows Windows 3.0 with Type Manager.

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from the ATM Control Panel. If you have a large amount of RAM installed in your machine, a large cache can reduce these font change delays.

A number of print timing tests were also run using the dot matrix printer. For this I compared the output produced with ATM, output produced without ATM, and output from COREL Draw which uses its own outline font technology to generate accurate output. Printing without ATM was naturally the quickest overall, but the output was very rough and completely inaccurate. Printing with ATM was slightly slower than COREL Draw at the high resolution but was virtually identical at the low resolution. The ATM output was higher quality than the COREL output in both resolutions. A page that took approximately 2.5 minutes to print from COREL took 3 minutes to print using ATM.

I also compared ATM on pages of normal text and found that ATM actually improved the quality of the output on the dot matrix printer. Print speed was a few seconds slower per page, but the pages matched the printout produced on the PostScript laser printer as far as line lengths and page breaks.

If you proof documents on a dot matrix for later printing on a PostScript printer, ATM makes sure your proof pages match your final output. Matching line ends and matching page breaks means one less thing to worry about when doing the final printing. Accurate screen representation means you can accurately place text and graphics onscreen and not get any surprises when you print.

The list price for ATM is US\$99. I purchased ATM by mail order for US\$65. It comes with the 13 fonts found in the original LaserWriter. For about US\$198 you can add the Adobe Plus Pack to give you the additional fonts found in most PostScript printers (35 in total).

127 127
Times

Figure 3 shows high-quality dot matrix output, using ATM.

127 127
Times

Figure 4 shows high-quality dot matrix output, without ATM.

127 127
Times

Figure 5 shows low-quality dot matrix output, using ATM.

127 127
Times

Figure 6 shows low-quality dot matrix output, without ATM.

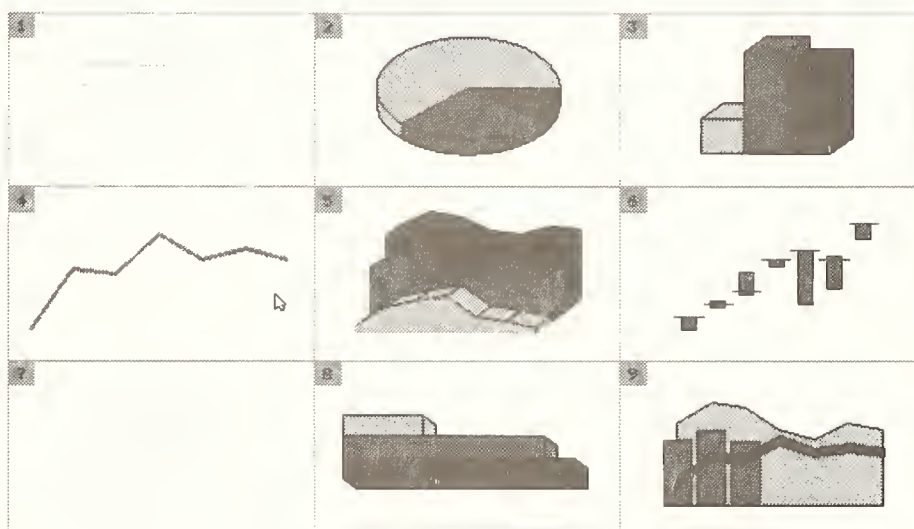
127 127
Times

Figure 7 shows Postscript laser output.

There are alternatives to Adobe Type Manager. Bitstream offers a similar product called FaceLift for Windows. Bitstream's FaceLift costs US\$99 and their FaceLift Companion Pack, similar to the Adobe Plus Pack, lists for US\$199. Zenographics' product, SuperPrint for Windows, has similar font technology but also adds a print spooler and improved printer drivers for Windows 3.0 that drastically improve printing performance to HP LaserJet type printers (in demonstrations I have seen). SuperPrint lists at US\$199.

PC Charting:

A Business, Not a Science



Harvard Graphics Gallery of chart types.

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Harriet Ji
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Harvard Graphics 2.3 and Freelance Plus 3.01 are upgrades of well-known graphics packages for DOS-based computers. DrawPerfect 1.1 is a new drawing package from WordPerfect Corporation. The following is a brief overview of these packages.

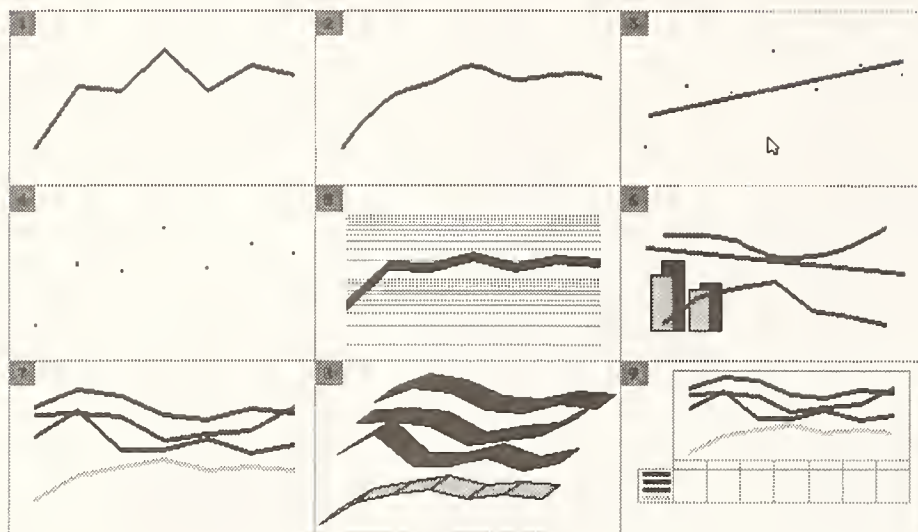
Harvard Graphics 2.3

Harvard Graphics has been the most popular graphics package for some time. Version 2.3 contains some basic improvements over previous releases, as well as some new features. Selecting a chart type has never been easier than with the new Gallery feature in Harvard Graphics. You see various types of sample graphs (Bar, Line, Pie) and choose the type you are interested

in. Once you have chosen the general type of chart, you are presented with a number of specific styles for that type of chart. Choose the one you like! You have the option of starting with a clean data screen or actually using the data from the example graphs.

This version also comes bundled with **Draw Partner**, a freehand drawing package that is very similar to the DRAW ANNOTATE facilities built into Harvard Graphics. More powerful than the DRAW ANNOTATE facilities, Draw Partner can be invoked while you're working in Harvard Graphics. Draw Partner gives you many more tools for manipulating illustrations, allowing you to truly fine tune your images. These tools include rotation, group and ungroup, and point editing of existing polygons. Draw Partner

Reviews

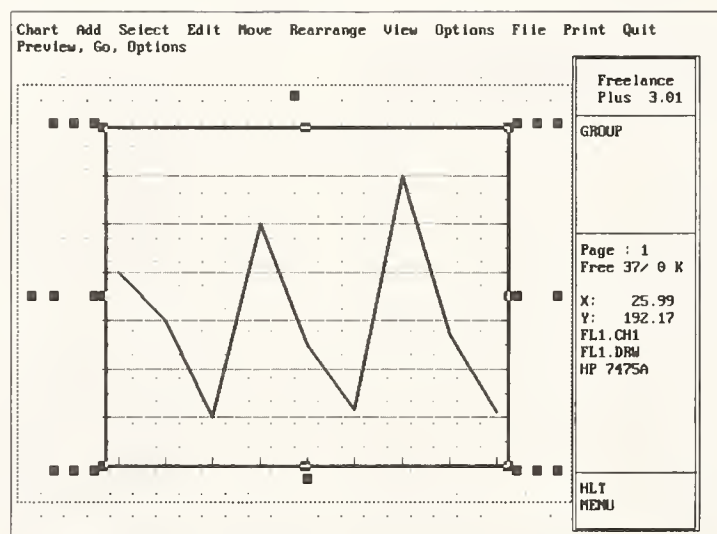


Harvard Graphics Gallery of line chart types.

also includes built-in Computer Graphics Metafile (CGM) import and export to allow you to bring in graphics from other programs (e.g., COREL Draw).

Harvard Graphics does have weaknesses though. Being more of a business graphics package than a scientific package, some common components of scientific graphics for journals are very difficult, if not impossible, in Harvard Graphics. Because it has no technique for superscripting or subscripting, chemical formulas and equations are extremely difficult to make. Properly orienting y-axis labels for scientific graphs is also difficult. In both cases, you could create the graph in Draw Partner, but this is neither convenient nor easy. Harvard Graphics is also limited in the number of data points it can handle per line. While 240 data points are quite adequate for drawing almost any line, it is often very inconvenient to manually reduce your data to fit within this limitation. Harvard Graphics also does not support error bars. The user interface for Harvard Graphics (how you interact with it) is easy to use, but is unique to Harvard Graphics. With Windows 3.0 becoming so popular on MS-DOS machines, it would be advantageous to have the capabilities of Harvard Graphics in a standard Windows interface.

Freelance drawing screen.



Importing spreadsheets into Freelance is done just like using a spreadsheet!

Line 1 Values: Move to opposite corner and press ENTER
06 422

View of Import File: UNITS.WKS

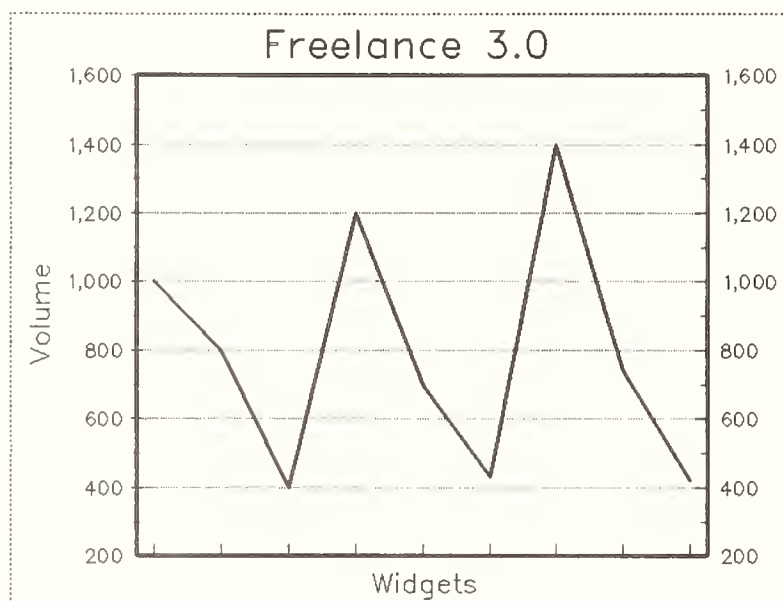
	A	B	C	D	E	F	G	H
	Jan	Feb	Mar	Q1 Total	Apr	May	Jun	
1 Units Shd								
2 Marathon	1000	1200	1400	3600	1451	1452	1300	
3 Triathlon	800	700	743	2243	756	823	754	
4 Triathlon	400	431	422	1253	456	501	432	
5 Total	2200	2331	2565	7996	2663	2776	2546	
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Freelance Plus 3.01

Freelance Plus 3.01, although not as popular as Harvard, is a very capable program. Like most charting programs, you can import spreadsheet data for charting. Freelance does this particularly well (Lotus developed this software) and lets you view the spreadsheet as you choose the data to import – very convenient if your data comes from Lotus 1-2-3! Freelance handles more data points than Harvard Graphics for most chart types. The number of data points varies depending on the number of different lines or series you want on a chart. For example, line graphs allow 500 data points if you have one to four lines on a graph and 225 data points if you have five to eight lines. If you have markers (symbols), the limits may be lower. Also, unless you are cautious, you may display partial or incomplete graphs without warning; you should cross-reference your data to ensure that all points have been plotted. Since you may overlay charts in Freelance, you can overlay any number of single-line graphs with 500 points each. Freelance will

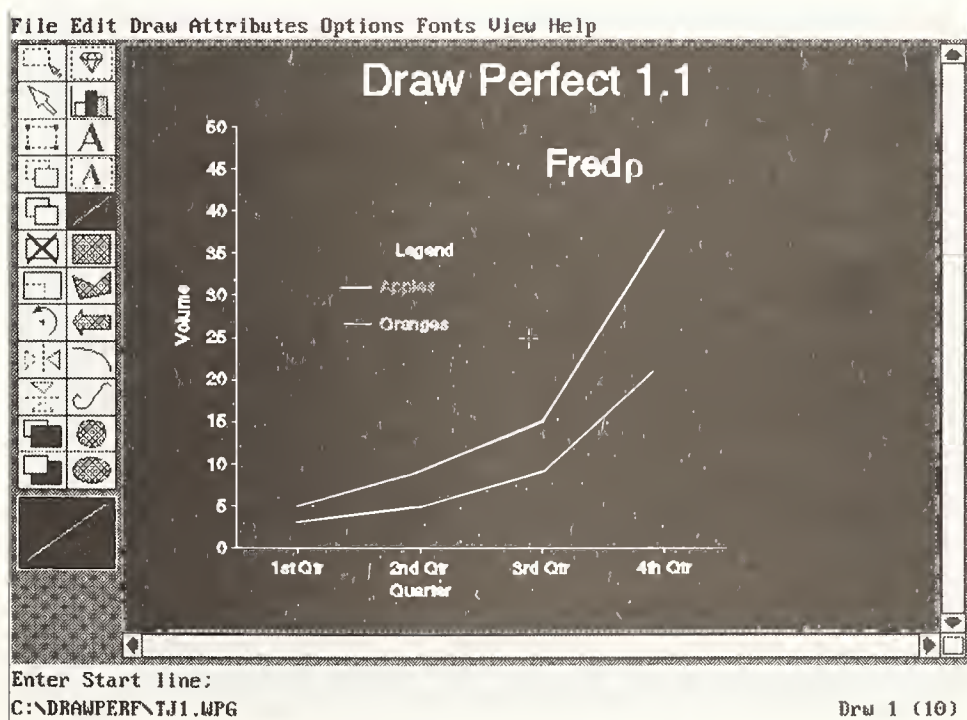
properly orient y-axis labels for scientific journals. In addition, Freelance provides good graphics import and export capabilities, allowing CGM export and PIC, CGM, or TIFF import. The user interface for Freelance is not a Windows-like interface, but it is not unique. Similar

to Lotus 1-2-3, the interface is very easy to learn if you are already using Lotus.



Freelance Print Preview Screen.

The DrawPerfect drawing screen.



DrawPerfect 1.1

For a limited time, WordPerfect provided UTCS with an evaluation copy of **DrawPerfect 1.1**, a new graphic software counterpart to their WordPerfect word-processing program. It is an object-oriented drawing and charting program (as are Harvard and Freelance). DrawPerfect supplies over 500 clip-art figures, a collection of customized templates and charts, and a menu of drawing and graphic-editing tools. While primarily benefiting WordPerfect users who need to add graphics and charts to their WordPerfect documents, DrawPerfect also helps those who wish to design presentations or publications, such as slides, transparencies, flyers, or pamphlets. You can retrieve a variety of ready-made images in DrawPerfect, edit these figures, combine them with drawings and text, and then insert the designs in WordPerfect 5.1 as graphic boxes.

DrawPerfect 1.1 looks very similar to WordPerfect 5.1, using both the

function keys and a pull-down menu to access the program features. It also offers a menu of icon-buttons as drawing and editing tools. You can click the mouse on these icon tools to draw lines, boxes, circles, arcs, curves, or polygons. You can also resize, stretch, copy, rotate, mirror, or move the objects and art from the clip-art figure collection in DrawPerfect. The program allows you to enter and format text with WordPerfect-like editing capabilities. DrawPerfect supports all of the standard business chart styles and does not seem to be limited in the number of data points it can handle.

Despite the benefits described above, most of which are for WordPerfect users, DrawPerfect 1.1 has some disappointing drawbacks. When compared with Windows-compatible graphic software, such as COREL Draw, or with DOS programs like Harvard Graphics or Freelance Plus, the graphic editing and drawing features in DrawPerfect 1.1 appear to be clumsy and difficult to handle. When you first start the program, most things appear very similar to a Windows program, but it does not behave at all like a Windows program. The drawing tools are made unnecessarily redundant, and it often takes separate, repeated steps to select, edit, or resize an object in the drawing. Frankly, with Windows 3.0 becoming so popular and WordPerfect for Windows announced, I can't explain why they would come out with a new product that isn't even close to following the Windows standard interface.

Harvard Graphics HyperShow

Harvard Graphics contains a screen show capability which allows you to display graphics (slides) sequentially. With release 2.3, Software Publishing has added "HyperShow", a more sophisticated display function. Using HyperShow, you now can create buttons within your graphics on the screen. These buttons can be defined to cause the screen show to jump to another location in the slide show. This gives you the ability to create nonlinear presentations on your computer screen.

Harvard's HyperShow is a good, basic, new feature allowing a user to relatively easily create non-sequential presentations. You can create a presentation with many different routes through the show. You choose the route using keys or by using mouse actions. You can also jump from one HyperShow to another. Mouse actions can also be designated function key equivalents so you do not need a mouse to use HyperShow.

Careful planning must be done before you create a HyperShow because the jumps you make in a show are based on the slide's number in the presentation. Adding or removing a slide causes the slides to be renumbered and the change in numbering may cause your show to jump to the wrong spot in the sequence. You should prepare and include in the show all the slides you want to use before you start adding the HyperShow portion of the show!

For limited applications, HyperShow may do the job. For more demanding applications, you might consider one of the more HyperCard-like Windows applications such as Plus or ToolBook.

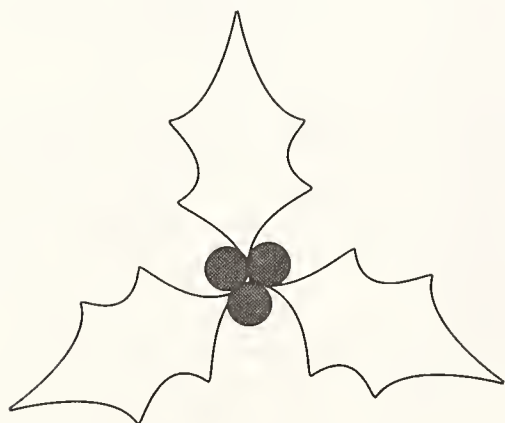
For more information, contact Terry Jones at 978-4924.

In conclusion, while all of these programs have their strengths, none are ideally suited for producing scientific graphics. Freelance Plus 3.01 is closer to scientific charting than the others but, as mentioned, still has some drawbacks. True error bars, superscripts and subscripts in titles and legends, large numbers of data points, greek and mathematical symbols are minimum requirements for scientific plotting. For more

conventional business graphics, all three are very capable.

With Windows 3.0 becoming increasingly popular, I think a good Windows charting package that also understands the scientific market might be a good seller.

For more information, please contact Terry Jones at 978-4924.



*Don't forget...it's
time to renew your
subscription!*

BRINGBACK Gives You a Second Chance

"Oh no! The power went off before I had a chance to save my file!"

"Uh oh, I just deleted the wrong file..."

"You mean I have to type that big long DOS command all over again?"

This minicatalogue of complaints is familiar to anyone who has been using a PC for any length of time. Programs to take care of the latter two already exist, but the first hasn't really been dealt with til now.

BRINGBACK, from Parsons Technology, is a neat little utility package with three modules, **PLAYBAK**, **COMEBAK**, and **CMDBAK**, one for each of these problems.

COMEBAK and **PLAYBAK** must both be installed as Terminate and Stay Resident programs (TSRs) which reside in RAM. **CMDBAK** is invoked at the DOS prompt. Normally, you would put any or all three in your **AUTOEXEC.BAT** file. For convenience, you can disable the TSRs from the DOS prompt at any time, or you can disable either of them just for the next command you enter.

PLAYBAK

PLAYBAK is the most unusual part of this package. It requires about 10.5 kilobytes (KB) of your Random Access Memory (RAM), as well as an average one megabyte (MB) on your hard disk, depending on the size of the files you access during your session. In return for this space, it records everything that happens from the moment you enter an application to the moment you

leave it. Everything—the environment setup of your PC, the files you used or created (even files you copied or deleted during a temporary exit to DOS), every keystroke you entered—is stored in a log file on your hard disk and can be reenacted by calling **PLAYBAK** at the DOS prompt. The **PLAYBAK** TSR starts when you enter an application and continues until you exit normally. This means that in case of power failure, a locked keyboard, or some accidental but disastrous keystroke(s) on your part, you can run **PLAYBAK** to put the world back the way it was before you entered the application and retrace your steps. In the case of a regrettable keystroke, you can stop the replay before it gets to that action. (If only there were a **PLAYBAK** for other areas of life!)

Another interesting feature allows you to copy the log file to another file that you can reload and use later, sort of a giant macro.

Parsons has tested **PLAYBAK** with sixteen software packages, including WordPerfect 5.0 and 5.1, Microsoft Word 5.0, and Lotus 1-2-3; it cannot run with Microsoft Works and Excel. You can add any other package you wish, but you are warned to test first. The manual documents peculiarities in the way **PLAYBAK** works with certain products. Of the supported pro-

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ducts, we tested WordPerfect and Lotus, but we also tried out SAS/PC, SPSS/PC, dBASE III Plus, and dBASE IV. All were successful.

There are some limitations to bear in mind. The most important is that PLAYBAK supports input from a keyboard only, i.e., no mouse or any other kind of input device can be used. Though it works with programs that can use a mouse, it does not record any activity by a mouse; indeed, it usually stops recording as soon as you use the mouse. Also, it records keystrokes in blocks of 25. This means that you could lose up to 25 keystrokes at the very end of the played-back session. If you are doing straight data entry, this loss is usually of little significance. In some other cases, however, a single keystroke can mean a great deal more than one character. Still, PLAYBAK offers far better recovery than has been available up to now.

COMEBAK

The COMEBAK module restores deleted files. Like PLAYBAK, it is a TSR and takes up about 15KB of your RAM to keep track of any files deleted during your computing session. When you want to restore a deleted file, you call the program from the DOS prompt.

COMEBAK shows a screen listing all deleted files in the order in which they were deleted. As you highlight each filename with the arrow keys, COMEBAK indicates whether there is an existing file with the same name and directory path. If there is, you can ask COMEBAK to compare the files, displaying any differences and putting them in context. You can also ask to see the contents of the deleted file.

By default, COMEBAK records up to 75 files at a time or fills 5MB of disk space, whichever comes first. Also by default, it remembers all deleted files, even those created and deleted automatically when you run your software. These defaults can be configured to suit your requirements.

CMDBAK

This module is not a TSR, but you can turn it on in your AUTOEXEC.BAT file so that it will always be available. When CMDBAK is on, it remembers the last 31 DOS commands you have entered. It has lots of switches, such as showing the cursor as a block, and choosing overwrite or insert as the default for editing recalled commands. Various function keys recall commands in different ways; for example, <F9> recalls the most recent command that starts with the character(s) you enter at the DOS prompt. However, the simplest way to scroll through the remembered commands is with the up and down arrow keys.

If you are the kind who likes to tinker with .BAT files to create your own "DOS" commands, you'll like CMDBAK's alias feature. Instead of cluttering up your directories with a lot of little .BAT files, you can put all of your customized commands in an alias file. For example, you might want a command called DSS that displays a directory sorted by file size. One line in your alias file would be DSS DIR | SORT/+13 | MORE. When CMDBAK is running with its alias switch turned on, you can enter DSS from the DOS prompt.

Putting It On and Taking It Off

BRINGBACK has a simple installation utility that runs from a floppy disk. Two or three choices are required, but the defaults should be satisfactory in almost any case—pressing <Return> a few times and then rebooting is about as challenging as it gets. The installation creates two subdirectories in your Root: \BRINGBAK and \H_DD_N\. The former contains program files for the various modules, the latter has the files created by PLAYBAK. The

installation also alters your AUTOEXEC.BAT to add \BRINGBAK to your PATH and to invoke the two TSR programs, COMEBAKR and PLAYBAKR. You can choose to skip this part of the installation if you wish. The manual discusses the relationship between these two programs and other TSRs you may be running.

A BBREMOVE utility is also provided, which the manual claims removes "any trace of BRINGBACK from your hard disk." This is not quite true, since it leaves behind the BRINGBAK directory; however, it does clean up your AUTOEXEC.BAT, remove the }H_DD_N{ directory, turn off the TSRs, and then prompt you to reboot.

Documentation

BRINGBACK comes with one slim, easy-to-read User Guide. The guide is well organized and complete, with step-by-step instructions, and well marked examples; the index could be expanded. Appendices include technical specifications and error messages. The latter section explains the meaning of each message and also tells you how to solve the particular problem.

Overall

BRINGBACK is a useful product, though it does potentially use up about seven megabytes of disk space. PLAYBAK alone would be worth considering, and the other modules make it that much more attractive. The price is attractive, too: US\$35 for a single copy, US\$21 for two to four copies, US\$19.25 for five to nine, and US\$17.50 for ten or more. Parsons Technology can be reached at (319) 395-9749.

WordPerfect 5.1 and Epson LQ-850/LQ-1050 Printers

Terry Jones
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WordPerfect users who select either the Epson LQ-850 or Epson LQ-1050 printer drivers will see the following on the Printer Helps and Hints screen: "Epson LQ-850/1050 printers must have firmware version N9xxxx [The firmware version number is six characters; only the first two characters are significant to WordPerfect] when using this printer definition. Run the self test to see what version you have." Unfortunately this message doesn't mean much to most people!

Printers today are complex and usually contain a computer to control their function. This computer is controlled by firmware. Firmware is software embedded right in the hardware, usually in a type of memory called Read Only Memory (ROM). As is altogether too common these days, software contains bugs (errors!) and so it is revised to eliminate these errors. The firmware version number identifies the revision level of the software.

Using a printer driver designed for the N9 firmware with a printer that contains other firmware results in

incorrect output, especially with graphics. WordPerfect 5.1 makes extensive use of graphics to print everything from pictures, boxes, and bars to special or foreign language characters.

You can easily determine the firmware version for your Epson printer by running the built-in self test. To run the self test on your Epson printer, you hold down the Form Feed button as you turn the printer on. The first thing the self test prints is the printer firmware version number. It then prints further diagnostics and font samples. Turn the printer off to stop the self test.

Looking at your firmware version number, it will probably start with the characters M8 or N9. If it starts with N9, you should use the WordPerfect LQ-850 or LQ-1050 driver to get the best printout. If it starts with M8, you have two choices. You can use a different driver for your printer or you can get your printer updated with more recent firmware from Epson.

WordPerfect has a driver called LQ-850 (M8 ROM) or LQ-1050 (M8 ROM) which can be used if your Epson was manufactured with the older M8 firmware in ROM. This driver can be obtained from UTCS or directly from WordPerfect. Using this alternate driver should make printing from WordPerfect work properly, but this will not help other programs you use with your printer.

Getting the firmware in your printer updated is the alternative. This involves sending your printer to the Epson Service Centre and have them update the firmware ROM chips. This is more work but offers some advantages. Your printer will be compatible with more recent LQ-850 and LQ-1050 printers and should work more reliably with other software.

For more information, please contact Terry Jones at 978-4924.

Planning and Coordination Moving Out of the Basement

Effective November 1, 1990, University of Toronto Planning and Coordination moved to 215 Huron Street, Fourth floor. My office has been moved from the Simcoe Hall basement to room 415. My phone number remains unchanged at 978-5138.

Two new staff appointments have been made in this group. Beverly Biderman has been appointed as Applications Planning Analyst; you can reach her through Sally Connor at 978-2217. Frank Pearce has been appointed as Technology Planning Analyst; his phone number is 978-1515. Both assumed their duties on November 1, and have their offices in room 416.

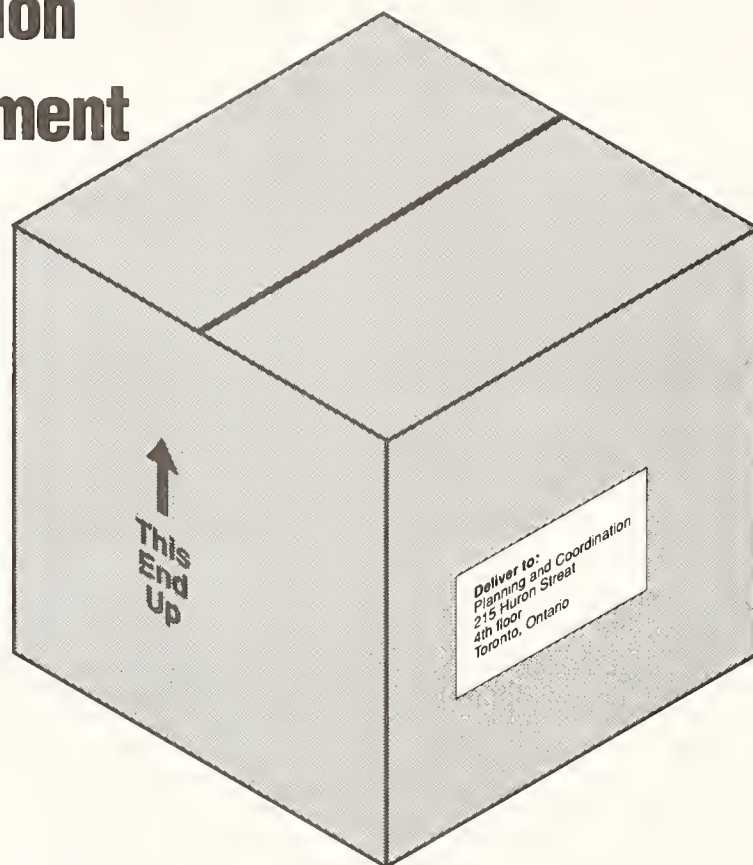
In the event that you would like to send electronic mail to either Frank or Beverly, their e-mail addresses are as follows:

Frank's is pearce@vm.utcs.utoronto.ca

Beverly's is biderman@vm.utcs.utoronto.ca.

Eva Swenson

eswenson@vm.utcs.utoronto.ca



Make the Connection

The University has recently acquired an Integrated Voice Messaging System (IVMS) from Bell Canada which will simplify the method by which we communicate with each other, and simplify how we communicate with and inform the community at large.

The OCTEL ASPEN is a computer system which is revolutionizing the way people communicate and certainly is changing the way they use their telephones.

The Enhanced Call Processing (ECP) applications available in the ASPEN system allow departments to construct special information "Bulletin Boards" tailored to their own unique requirements where callers can select the information they need. Information can be built into a bulletin board application which will allow the caller to dial a "general enquiry" number and be offered a series of choices to access various pieces of information. Calls processed in this manner will reduce the amount of time currently spent on the telephone answering the same questions over and over again.

IVMS also provides individualized answering on your personal telephone. Unlike a normal answering machine, IVMS allows you to access the advanced features of voice messaging such as receiving, sending and responding to messages, future delivery, and message storage. Another attractive feature of this function is "Outcalling." ASPEN can be programmed by the subscriber to notify them at designated times and locations when messages arrive in their mailbox.

If you want to hear more about how IVMS will assist you in managing your time and your information, please contact the Voice Communications Department at 978-1723.

Ann McLean

Voice Communications, Computing & Communications

How to Analyze Repeated Measures Designs Using SAS

Sandra Gardner
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As part of my role supporting the use of statistical software such as SAS, SPSS, and SYSTAT, I often help people analyze data from experiments which have repeated measures designs. Analyzing these kinds of experimental data is not straightforward. How should the data be entered into the program? What procedure or option should be chosen? How does one interpret the output?

In this first of two articles, I hope to make the analysis of a repeated measures design a little easier. This article will discuss how to analyze repeated measures data using SAS. The next article will cover how to use SPSS and SYSTAT to do the same analysis. To keep the article focussed on 'how to use SAS', I have to assume you have some familiarity with analysis of variance techniques and terminology. This article also assumes you know how to build and submit a SAS program which creates a SAS data set and executes a SAS procedure (using SAS/PC or SAS under CMS).

Repeated measures designs are quite common in many fields of research—behavioural sciences, nutritional sciences, and medical research, to name a few. In a single factor repeated measures (or within-subjects) design, for example, a subject's response is measured at different points in time. One example of this type of design would be the study of the effects of three

drugs on a subject's length of time to complete a specific task. Every subject is given the three drugs, in random order and at different times, and the length of time to completion of the task is recorded on each occasion. The research question would be 'Are there any differences in the mean response after each treatment?'. Another example of this type of design would be the study of the effect of one drug across time. Each subject is given the same drug at different dates. The research question could then be 'Are there differences in the mean response across time?'.

Repeated measures designs have one or more within-subject factors and may have one or more between-group factors. Between-group factors are the typical factors of classical experimental design and each subject can belong to only one group. A possible between-group factor could be the gender of the subjects for the first example and treatment group for the second example. Repeated measures designs are often chosen when people are the subjects. The variation amongst the subjects is isolated from the treatment variation and the error term. Subjects, therefore, act as their own control.

SAS has two procedures to analyze repeated measures data: PROC ANOVA and PROC GLM. PROC ANOVA is more efficient when the data is balanced. If there

are missing data you should use PROC GLM. (PROC CATMOD will also analyze repeated measures if your response variable is categorical rather than continuous, but that is another topic.) The major statements to be used with these procedures are the MODEL, REPEATED, TEST, and MEANS statements. They will be discussed in more detail later. First, you must consider how the data should be entered.

You have two choices for entering your data into a SAS data set. I will call these two choices univariate and multivariate *data presentation* methods. The univariate data presentation method is the typical method for entering data for a factorial design. There is one response (or dependent) variable and one variable for each factor (repeated or otherwise). The values of the response variable is the information being studied, e.g., test score. The values of the factor variables describe what the levels of the within-subject and/or between-group factors were when this response was observed. There will be several observations per subject, with one observation for each level or combination of levels of the within-subject factors.

In contrast, the multivariate data presentation method, typically used for multivariate data analysis, has several response variables, one variable for each level or combination of levels of the within-subject factors (for instance, B1C3, is the measurement for B, level 1, and C, level 3) and one variable for each between-group factor. There is only one observation per subject since each subject can belong to only one group. It is helpful to use SAS names for the response variables in the multivariate data presentation method which reflect the level or combination of levels of the within-subject factors. This makes subsequent coding of the MODEL and REPEATED statements a little easier.

There are advantages and disadvantages to both methods of data presentation. The multivariate

data presentation method is preferred since SAS will be able to produce both the univariate and multivariate *analytical* results (to be discussed later) and requires less memory to complete the analysis. One disadvantage of this method of data presentation is that the MEANS statement cannot be used for the within-subject factors. You cannot easily produce the means for each level or combination of levels of the within-subject factors or perform post-hoc tests such as Duncan's multiple range test. Another disadvantage of this method is that if one of the response variables is missing SAS throws away the whole observation.

Probably the only advantage of using the univariate data presentation method is the ability to use the MEANS statement for the within-subject factors. It is important, though, to supply the correct error term from the model when asking for post-hoc tests such as Duncan's multiple range test to be performed. If you want to use univariate analytical methods and there is some missing data, less data will be lost using this data presentation method.

There are two major disadvantages to using the univariate data presentation method. You can only perform univariate analysis and you often run out of memory when there are several repeated factors. When using this method, SAS requires the complete model be supplied in the MODEL statement. The model often has a large number of nested and/or interaction terms (depending on the exact design) which creates a large design matrix and causes out of memory problems to occur during processing of the data. Memory problems can occur using both SAS/PC and SAS under CMS.

There are two different approaches to analyzing repeated measures data, namely, the univariate and multivariate *analysis* methods. Here the univariate approach is a modification of the classical analysis of variance techniques which is well documented in books by Winer (1971) and

Keppel (1982). These analytical results can be summarized in an analysis of variance table which includes the special F-ratios and associated probabilities to test the significance of all the main effects and interactions. If there are no between-group factors, the denominators of the F-ratios are the mean squared error terms estimated by the interaction of the subject term and the within-subject factors. If there is a between-group factor, the mean squared error terms are estimated by the interaction of the subjects nested within the grouping factor with the within-subject factors.

The multivariate approach is based on multivariate analysis of variance techniques and is described in an article by Cole and Grizzle (1966). SAS produces several multivariate tests for the main effects and interaction of the within-subject factors, including Wilks' Lambda and Pillai's Trace.

What analytical method should be chosen? The assumptions behind the univariate model are more restrictive than the multivariate model and the consequences of not checking whether your data meets these assumption is that the univariate F-tests for the repeated factor may give liberal results. This means that the reported type-I error (p-value) may be too low and there may appear to be a significant result when there is no real difference in means of the repeated factor. The restrictive assumptions of the univariate model are discussed further below.

I will present two examples of repeated measures designs using both the univariate and multivariate presentation methods and both the univariate and multivariate analysis methods. The first example is taken from Keppel, 1982, Section 17.3. This design has one within-subject factor (treatment) where each of the six subjects has been given all three treatments. When the data is entered in the multivariate presentation style, there are four variables, subject number and the results from each of the treatments,

SUBJECT	T1	T2	T3
1	13	24	22
2	6	30	29
3	25	13	23
4	20	16	25
5	25	37	16
6	19	30	12

Table 1

```
proc glm;
  model t1 t2 t3=/nouni;
  repeated trtmt 3/printe;
```

Figure 1

Applied to Orthogonal Components:					
Test for Sphericity: Mauchly's Criterion = 0.9864094					
Chisquare Approximation = 0.0547352 with 2 df Prob > Chisquare = 0.9730					
Manova Test Criteria and Exact F Statistics for					
the Hypothesis of no TRTMT Effect					
H = Type III SS&CP Matrix for TRTMT E = Error SS&CP Matrix					
S=1 M=0 N=1					
Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.73739169	0.7123	2	4	0.5437
Pillai's Trace	0.26260831	0.7123	2	4	0.5437
Hotelling-Lawley Trace	0.35613136	0.7123	2	4	0.5437
Roy's Greatest Root	0.35613136	0.7123	2	4	0.5437

Figure 2

General Linear Models Procedure						
Repeated Measures Analysis of Variance						
Univariate Tests of Hypotheses for Within Subject Effects						
Source: TRTMT						
DF	Type III SS	Mean Square	F Value	Pr > F	Adj G - G	Pr > F
2	147.44444444	73.72222222	0.92	0.4292	0.4283	0.4292
Source: Error(TRTMT)						
DF	Type III SS	Mean Square				
10	799.88888889	79.98888889				
Greenhouse-Geisser Epsilon = 0.9866						
Huynh-Feldt Epsilon = 1.6253						

Figure 3

and six observations (see Table 1). The corresponding SAS code to analyze this data is listed in Figure 1. The PROC GLM, MODEL and REPEATED statements are required. Since there is no between-group factor, the CLASS statement is not necessary. In the MODEL statement you list the variables which comprise the repeated measures as the dependent variables followed by the equal sign. The NOUNI option, in this case, suppresses each dependent variable being analysed separately. The REPEATED statement describes how the dependent variables are to be analyzed collectively. In this example, TRTMT is the name given

to the within-subject factor and it has three levels. The three variables, T1, T2, and T3, are transformed (by the default CONTRAST transformation) into two new variables named TRTMT.1 and TRTMT.2 for computational reasons. The PRINTE option prints the partial correlation coefficients for the error sums of squares and cross-product matrix, as well as the test for sphericity for the orthogonal components.

By default, both the multivariate and univariate analyses are performed. The multivariate test for TRTMT is given in Figure 2. The univariate test for TRTMT is given in Figure 3. Both tests have similar results, i.e., there is no significant

differences amongst the treatment means. What if the results are contradictory? It is then important to examine the assumptions behind the model.

For the univariate F-tests to be valid, an important assumption about the variance-covariance structure amongst the repeated measures must be satisfied. This assumption is, generally speaking, that there is equality of variances and equality of covariances (Huynh and Feldt, 1970). Since SAS automatically transforms the repeated measures, that assumption is tested by the test for sphericity on the orthogonal components. It tests the hypothesis that the orthogonal components are

SUBJECT	TRTMT	RESULT
1	1	13
1	2	24
1	3	22
2	1	6
2	2	30
2	3	29
3	1	25
3	2	13
3	3	23
4	1	20
4	2	16
4	3	25
5	1	25
5	2	37
5	3	16
6	1	19
6	2	30
6	3	12

Table 2

uncorrelated and have equal variance (Freund, Littell, and Spector, 1986). If the hypothesis is rejected, then the univariate F-tests are too liberal and the approximate tests provided by the Greenhouse-Geisser and Huynh-Feldt adjusted p-values should be used instead. The other alternative is to use the multivariate analysis technique where the assumption about the variance-covariance structure does not apply. If the hypothesis is not rejected, the univariate F-tests are more powerful than the multivariate tests, i.e., better able to detect differences amongst treatment levels if they exist.

In our example, the test for sphericity for TRTMT (see Figure 2) results are printed with the multivariate output and indicate that the F-tests are valid ($P=0.9730$). As well, the Greenhouse-Geisser and

Huynh-Feldt adjustments to the p-value, in the univariate output, are negligible since the epsilon values, 0.9866 and 1.6253 respectively, are close to or greater than one (see Figure 3).

The REPEATED statement in PROC GLM produces a lot of output which is not that easy to comprehend. The multivariate analysis of the repeated measures may be suppressed by adding the option NOM to the REPEATED statement. Unfortunately, the results of the univariate analysis are not summarized in a single ANOVA table. You have to know what the design is in order to write out the ANOVA table yourself. For example, in Figure 3, the Error (TRTMT) term is really SUBJECT*TRTMT. See Keppel, 1982, page 389 for the ANOVA table for this example.

Another way to perform the univariate analysis is to enter the data in the univariate presentation method (see Table 2) and enter all main effects, interactions and nested effects, where required, in the MODEL statement. Figure 4 gives the SAS code for the example discussed previously. Notice that the CLASS and TEST statement are now required. The TEST statement tests the hypothesis of no treatment differences using the SUBJECT*TRTMT interaction as the denominator of the F-ratio. See Figure 5 for the test results which

```
proc glm;
  class subject trtmt;
  model result=subject trtmt subject*trtmt;
  test h=trtmt e=subject*trtmt;
  means trtmt/duncan e=subject*trtmt;
```

Figure 4

Tests of Hypotheses using the Type III MS for SUBJECT*TRTMT as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TRTMT	2	147.4444444	73.7222222	0.92	0.4292

Figure 5

agree with the test results of *Figure 3*. Please remember that there are no tests for sphericity or adjusted F-tests when you analyze your repeated measures data in this way. The MEAN statement, though, allows post-hoc tests to be performed on the repeated factor provided that the correct error term is used. See the example MEANS statement in *Figure 4*.

The second example I would like to discuss is taken from Winer, 1971, page 546. This design has six subjects divided into two groups, which is recorded by the between-group factor A. The two within-subject factors B and C have three levels each, so subjects are measured nine times. See Table 3 for the multivariate data presentation of the within-subject factors and the between-group factor. Notice that the variable names for the repeated measures reflect the level of the within-subject factors. For example, B1C3, is the measurement for B, level 1, and C, level 3. The SAS code required to analyze the data is given in *Figure 6*. A CLASS statement for the between-group factor A is now required. A is also added to the MODEL statement after the equal sign. The REPEATED statement lists the two within-subject factors and the order is important. The repeated measures in the MODEL statement have been arranged so that the level of C changes before the level of B. So, in the REPEATED statement, factor C is listed last.

The analytical results include the multivariate tests for the effects B, C, B*A, C*A, B*C, and B*C*A. The test for the between-group effect is the same as the univariate test for A and is displayed in *Figure 7*. The univariate tests for B and B*A are also given. Notice that Greenhouse-Geisser adjustment indicates that there may be a problem with the B*A F-test (p-value of 0.0293 is adjusted

SUBJECT	A	B1C1	B1C2	B1C3	B2C1	B2C2	B2C3	B3C1	B3C2	B3C3
1	1	45	53	60	40	52	57	28	37	46
2	1	35	41	50	30	37	47	25	32	41
3	1	60	65	75	58	54	70	40	47	50
4	2	50	48	61	25	34	51	16	23	35
5	2	42	45	55	30	37	43	22	27	37
6	2	56	60	77	40	39	57	31	29	46

Table 3

```
proc glm;
class a;
model b1c1 b1c2 b1c3 b2c1 b2c2 b2c3 b3c1 b3c2 b3c3=a/nouni;
repeated b 3 polynomial,c 3/printe summary;
```

Figure 6

General Linear Models Procedure					
Repeated Measures Analysis of Variance					
Tests of Hypotheses for Between Subjects Effects					
Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	1	468.16667	468.16667	0.75	0.4348
Error	4	2491.11111	622.77778		

General Linear Models Procedure							
Repeated Measures Analysis of Variance							
Univariate Tests of Hypotheses for Within Subject Effects							
Source: B							
DF	Type III SS	Mean Square	F Value	Pr > F	Adj G - G	Pr > F H - F	
2	11167.00000000	5583.50000000	63.39	0.0001	0.0003	0.0001	
Source: B*A							
DF	Type III SS	Mean Square	F Value	Pr > F	Adj G - G	Pr > F H - F	
2	999.00000000	499.50000000	5.67	0.0293	0.0569	0.0293	
Source: Error(B)							
DF	Type III SS	Mean Square					
8	704.66666667	88.08333333					
Greenhouse-Geisser Epsilon = 0.6476							
Huynh-Feldt Epsilon = 1.0668							

Figure 7

General Linear Models Procedure
Repeated Measures Analysis of Variance
Analysis of Variance of Contrast Variables

B.N represents the nth degree polynomial contrast for B

Contrast Variable: B.1

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MEAN	1	11163.000000	11163.000000	73.44	0.0010
A	1	675.000000	675.000000	4.44	0.1028
Error	4	608.000000	152.000000		

Contrast Variable: B.2

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MEAN	1	4.00000000	4.00000000	0.17	0.7050
A	1	324.00000000	324.00000000	13.41	0.0216
Error	4	96.66666667	24.16666667		

Figure 8

to 0.0569). The multivariate test, Wilk's Lambda, gives a p-value of 0.0617 for that effect. The ANOVA table for the univariate results can be found in Winer, 1971, page 549. (See Looney and Stanley, 1989, for a good discussion on the interpretation of the analytical results when there is a grouping factor.)

In the REPEATED statement, I have chosen the type of transformation I would like for the levels of B. The POLYNOMIAL transformation allows me to test for trends in the mean responses across the levels of B. The SUMMARY option displays these test results (see Figure 8). Since B has three levels, SAS creates two transformed variables named B.1 and B.2. B.1 is the linear combination of the repeated measures such that testing the hypothesis that the mean of B.1 is 0 is equivalent to testing the hypothesis that there is no linear trend across the means. Similarly, testing the hypothesis that the mean of B.2 is 0 is the test for the quadratic trend across the means (other transformations would imply different interpretations on B.1 and B.2). In our example, the MEAN test indicates there is a significant linear trend ($p=0.0010$) in the means across the levels of B. The test for the A effect is not significant, indicating that the linear pattern for B is the same for all levels of the between-group factor A.

```
proc glm;
class subject a b c;
model result=a subject(a) b a*b b*subject(a) c a*c c*subject(a)
b*c a*b*c b*c*subject(a);
test h=a e=subject(a);
test h=b e=b*subject(a);
test h=a*b e=b*subject(a);
test h=c e=c*subject(a);
test h=a*c e=c*subject(a);
test h=b*c e=b*c*subject(a);
test h=a*b*c e=b*c*subject(a);
```

Figure 9

SUBJECT	A	B	C	RESULT
1	1	1	1	45
1	1	1	2	53
1	1	1	3	60
1	1	2	1	40
1	1	2	2	52
1	1	2	3	57
1	1	3	1	28
1	1	3	2	37
1	1	3	3	46
2	1	1	1	35
2	1	1	2	41
2	1	1	3	50
2	1	2	1	30
...				

Table 4

Experimenting with other transformations of the repeated measures is a way of performing post-hoc tests on the within-subject factors.

Table 4 displays the data from the previous example in the univariate presentation method. Figure 9 gives the SAS code to analyze this design. Notice that the presence of a between-group factor requires that SUBJECT(A) and all appropriate interactions be terms in the model. Separate TEST statements need to be included for all main effects and interaction terms.

It has been my experience that SAS will run out of memory if the repeated measures design is more complicated than the second example and if you choose the univariate data presentation method with the corresponding univariate analysis. The multivariate data presentation method and the use of the REPEATED statement gives the same univariate results, but this method can handle complicated designs more efficiently.

I hope this article has helped you to understand how to analyze repeated measures data using SAS. I have included a list of references which discuss this topic in further detail. If you have any questions please call me at 978-5128 or send an e-mail message to sgardner@vm.uts.utoronto.ca.

References:

Cole, J.W.L. and Grizzle, J. E. "Applications of Multivariate Analysis of Variance to Repeated Measurements Experiments" *Biometrics*, vol. 22, (1966), 810-828.

Freund, R. J., Littell, R. C., and Spector, P.C. *SAS System for Linear Models, 1986 Edition*. SAS Institute, Inc., 1986.

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Keppel, G. *Design and Analysis, A Researcher's Handbook (2nd Ed.)*. Prentice-Hall, Inc., 1982.

Looney, S.W. and Stanley, W.B. "Exploratory Repeated Measures Analysis for Two or More Groups" *The American Statistician*, vol. 43, No. 4 (1989), 220-225.

Winer, B.J. *Statistical Principle in Experimental Design (2nd Ed.)*. New York: McGraw-Hill, 1962.

New from Dynamical Systems

Andrzej Pindor
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Dynamical Systems, Inc., author of Dynamical Software and the Chaos in the Classroom series, has announced the availability of a forecasting program for nonlinear time series. It is called **NLF: Nonlinear Forecasting for Dynamical Systems**. The program can analyze existing data for predictability or predict new values. It has a convenient mouse/menu interface and uses high-resolution graphics. The new package can be used independently or in conjunction with Dynamical Software.

Vendor:
Dynamical Systems, Inc.
P.O. Box 35241
Tucson, AZ 85740
USA
(602) 292-1962

Pricing:

Standalone version	US \$200
Standalone version with source code	US \$600
Enhancement to Dynamical Software (available to registered DS owners only)	US \$150
Enhancement to DS with source code	US \$500
Extra manuals	US \$25
Raindrop print driver (required for screen dumps to a printer)	US \$27.95

Hardware Requirements:

IBM PC or compatible,
640 kilobytes RAM, EGA or VGA
graphics.
Hard disk and math coprocessor
recommended but not required.

ISAAC – Information System for Advanced Academic Computing

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ISAAC is meant to serve as a clearing-house for information about the use of IBM computers and compatible software as aids to instruction and research at the higher-education level. It is funded by IBM. Access is free to all faculty, students, and staff at institutions of

higher education, and to members of participating professional societies.

ISAAC consists of a bulletin board and numerous databases. The bulletin board is made up of rooms which contain entries relating to the following topics:

- | | |
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| - Computer Science | - Life Sciences |
| - Distance Learning | - Mathematics |
| - Education | - Physical Sciences |
| - Engineering | - Social Sciences |
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The databases are grouped into four categories: "Sources of Information" such as software reviews, software libraries, and so on; listings of "Academic Software Packages" that are available from many sources; "General Information" about computing; and "Abstracts of Projects" which used IBM compatible computers and software. There is also an additional database, "Disability Resources."

ISAAC has a database search software program that allows you to find the desired information easily. For instance, a search of the "Academic Software Packages" category for the presence of the strings "regression" and "simple" produced a list of 18 statistical packages (the string "regression" alone gave a list of 121 packages). Choosing an item from this list gives you one or two pages of detailed information about a given package.

You can gain access to ISAAC either through a BITNET address (if you have one) or from a PC using a modem. If you are interested, send e-mail to isaac@uwaee (BITNET), or write to:

Isaac Access
m/s FC-06
University of Washington
Seattle, WA 98195
USA.

For more information, call Andrzej Pindor at 978-5045.

Public-domain 3D Graphics Programs for PCs

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A number of commercial packages for three-dimensional (3D) graphics is available. They are of different scope and quality, but they have one thing in common: they are expensive. If you would like to have 3D graphics software on your computer, but do not feel that your requirements justify spending \$500 or more, you should look into public-domain software. One of the biggest public depositories of computer software (public-domain and shareware) is anonymous file transfer protocol (ftp) site `wsmr-simtel20.army.mil`. There I found two 3D graphics programs that may be of interest to some users. One is **SURFMODL**, a 3D solid modeling program; and the other is **3DSUR**, a program for drawing 3D surfaces determined by

the function $z=f(x,y)$. I have described these programs briefly below. (Caution: It is always important to remember that "anything free comes without guarantee.")

SURFMODL

SURFMODL is a general-purpose surface modeler. It creates displays of three-dimensional wire-frame images, removes hidden lines, and performs surface modeling (each surface element may have different "material properties," described by three reflectivity constants). With SURFMODL, you can view any object from any angle, with single or multiple light sources. The program also has a module to generate objects of revolution, and another one for creating animations and demonstrations from saved SURFMODL screens. *Figure 1* and *Figure 2* show a wire-frame and a surface model of a 3D object created by the program. A 24-page manual is supplied as a separate file on the diskette when you pick up SURFMODL. Although it is very helpful, the manual omits many important

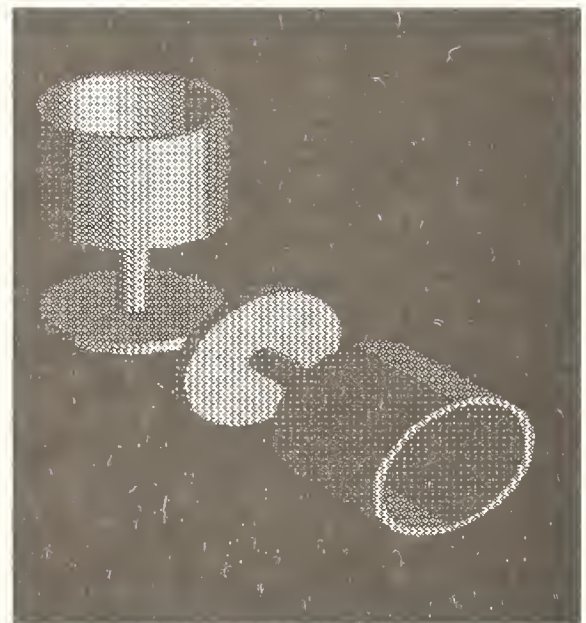


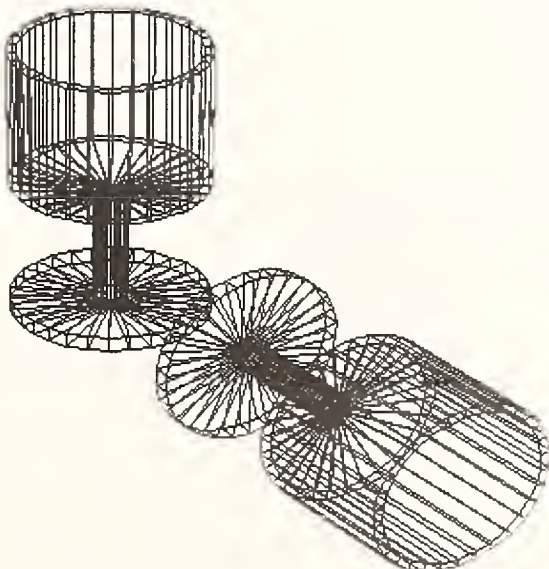
Figure 2

details; for instance, it does not explain how the values of the display parameters govern what the picture looks like. You will discover such omissions yourself by trial and error.

3DSUR

3DSUR is a program for plotting surfaces of the two variables $z=f(x,y)$. The program provides some built-in functions, so you can see immediately how it works by plotting the functions and playing with the parameters. You can enter your own functions, which can be built up of the following elementary functions: `sin`, `cos`, `tan`, `arctan`, `exp`, `ln`, `abs`, and `sqrt` with the use of the algebraic operators (+, -, /, ^). There are several modes of plotting the function, such as three methods of hidden line removal, plotting without hidden line removal, plotting in polar coordinates, and so on.

Figure 1



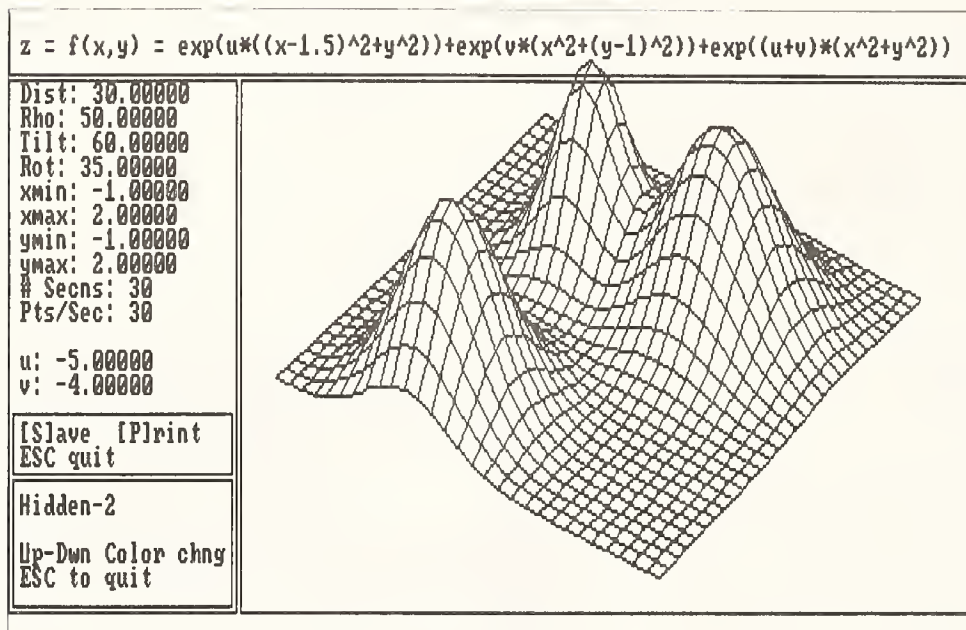


Figure 3

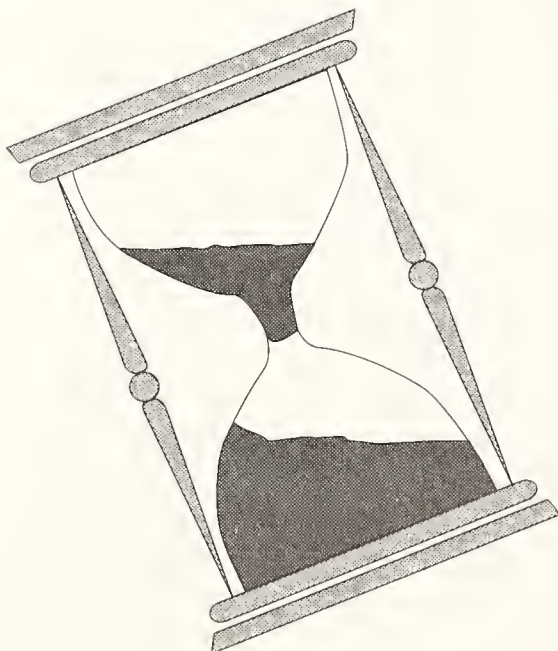
3DSUR is menu driven and very easy to use. It allows you to save the pictures you have created, and then load and display them later. Figure 3 shows one example of the program's graphing screen with a drawn surface. At the top of the screen you can see the formula defining the surface, and on the left-hand side you see the values of the parameters that determine the way in which the surface is drawn. If you

want to produce hard copies of your pictures, you should know that this program supports only Epson printers.

All the figures you see in this article were obtained using a screen-capture program called HiJaak. SURFMODL and 3DSUR are available free of charge from UTCS. If you are interested in obtaining either program, call Andrzej Pindor at 978-5045.

Hardware Requirements:

IBM PC compatible microcomputer, CGA, EGA or VGA graphics (SURFMODL supports PC3270, AT&T 6300, and Hercules graphics also), 128 kilobytes or more RAM, DOS 2.0 or later.



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New FORTRAN Subroutine Library – Free

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The Engineering and Information Systems Department of the National Surface Weapons Center in Dahlgren, Virginia, USA, has released for public use its subroutine FORTRAN library in the source form. UTCS has obtained this library and will give interested persons access to it. The contents of the library are as follows:

Elementary operations (machine constants, cube root, rotation of the axes, coordinate conversion, and so on)	37 routines
Geometry (e.g., determining whether a point is inside or outside a polygon)	4 routines
Special functions	78 routines
Polynomials	23 routines
Solutions of non-linear equations	11 routines
Vectors	29 routines
Matrices (includes solutions of linear equations)	74 routines
Large systems of 200-400 linear equations	3 routines
Banded matrices	30 routines
Sparse matrices	53 routines
Eigenvalues and eigenvectors	14 routines
λ_1 solution of linear equations	1 routine
Least square solutions of linear equations	13 routines
Optimization	7 routines
Transforms (inverse Laplace transform, Fast Fourier Transforms (FFTs), and discrete sine and cosine transforms)	10 routines
Approximations of functions	4 routines
Curve fitting	35 routines
Surface fitting over rectangular grids	3 routines
Surface fitting over arbitrarily positioned data points	2 routines
Manifold fitting	4 routines
Numerical integration	6 routines
Integral equations (Fredholm integral equation of the second kind)	1 routine
Ordinary differential equations/ Initial value problem	7 routines
Partial differential equations	1 routine
Random number generation	2 routines

Functions and subroutines are written in FORTRAN 77. Since they come from a variety of sources, the in-line documentation and style of code are not uniform. The source code is accompanied by a 500 page manual; if you are interested in specific routines, you may copy the relevant pages.

If you would like more information about the FORTRAN library, please contact Andrzej Pindor at 978-5045.

Alternatives to Full-fledged Statistical Packages

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Occasionally I receive queries from users who need a program to solve a very specific problem repeatedly—regression, for example—and who do not want to bother with a full-fledged package like SAS or SPSS. Depending on the problem, sometimes you can find programs with a more specific focus, perhaps for free (if they are in the public domain). In response to a user's query about regression, I found a program called **STATREGR**, which performs interactively a multivariate regression. Written by Professor Timo Salmi of the University of Vaasa, Finland, STATREGR is available in two versions: a free, public domain version, which you can obtain from the University of Vaasa by anonymous file transfer protocol (ftp); plus a full version which you can purchase by contacting Professor Salmi. (A few other

simple statistical programs also are available from Professor Salmi.)

STATREGR is very easy to use. You either enter the data from a keyboard or instruct the program to read data from a file, name the dependent and independent variables, and let the program do the rest. STATREGR even shows you a simple plot so that you can see for yourself how the regression line fits the data. The public domain version of the program is limited to four variables and 100 observations. A full version of the program can handle 25 variables and 400 cases.

If your computing needs have a very narrow focus, you don't have room on your hard disk for a large program, and/or you do not want waste time learning the syntax and philosophy of a big package, a program that meets your needs might be available. If you do not

know how to go about looking for such a program, we may be able to help you.

If you would like to see STATREGR in action, I have a copy of the program. For more information or a demonstration, call Andrzej Pindor at 978-5045.

Hardware Requirements:

IBM PC or compatible,
CGA, EGA or VGA graphics.

Vendor:

Prof. Timo Salmi
University of Vaasa
Finland
INTERNET address:
ts@chyde.uwasa.fi (preferred)
BITNET address: salmi@finfun

Pricing:

US \$134.50 for a single machine
US \$259.50 for a site license

SPSS News

It is time to renew your license for SPSS/PC for the period from November 1, 1990 to October 31, 1991. The renewal fee this year is \$100 for the entire package. If you wish, you can purchase SPSS/PC's data entry module alone for \$40 per machine. Network licenses are \$50 per station. Renewal notices will be mailed, but if you require a renewal form, call Evelyn Ward at 978-4990 to have one sent to you.

Renewal Notes

At renewal time, if you wish to update or install a program and you have to borrow installation diskettes from UTCS, there are a few things you should keep in mind. UTCS has a limited number of copies of each program available, so please call ahead to reserve the diskettes you require. This way we can ensure that they are on hand when you come in with your renewal form. A twenty-five dollar deposit for each box of diskettes is required. (SPSS requires two boxes.) Cash, cheques, appropriation accounts, and CAN numbers are acceptable forms of deposit. When you return the diskettes, UTCS refunds your money. Call Evelyn Ward at 978-4990 if you would like more information.

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SUN 3/280s, 16 megabytes of memory (one.cdf)

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Ontario Centre for Large Scale Computation (OCLSC)

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- VAX 8350 + MicroVAX II, VAX-11/750, and SUN 3 provide VMS front-end services

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 BC = Bancroft Building
 ER = Erindale
 MP = McLennan Physical Labs

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Ramsay Wright, 25 Harbord St., Rooms 211, 213

Robarts, Robarts Library, 130 St. George St., Room 1061A

Sidney Smith (Sidney), 100 St. George St., Room 1071, 2105

St. Michael's College, 121 St. Joseph St., Room 107

Trinity College, 6 Hoskin Ave., Room 024

Victoria University, 73 Queen's Park Cres., Room 208

Access Hours

Sites	Hours of Access				Restrictions* Advising	
	Mon-Thurs	Fri	Sat	Sun		
CAO	10:00-18:00	10:00-18:00	closed	closed	Research	978-HELP
CDF	24 hrs	24 hrs	24 hrs	24 hrs	Undergrads	No
EA	24 hrs	24 hrs	24 hrs	24 hrs	None	978-HELP for Research
Erin (2039)Δ	9:00-17:00	9:00-17:00	12:00-16:00	12:00-16:00	Research	Rm 2005
(2045-46-47)	24 hrs	24 hrs	24 hrs	24 hrs	Undergrads	Rm 2005
(235)†	8:00-22:00	8:00-17:00	closed	closed	None	Rm 2046
Ramsay Wright	7:00-21:00	7:00-18:00	closed	closed	Undergrads	No
Robarts	8:30-24:00	8:30-24:00	9:00-22:00	13:00-22:00	None	978-HELP for Research
Sidney	7:00-24:00	7:00-24:00	7:00-24:00	7:00-24:00	None	978-HELP for Research
St. Michael's	24 hrs	24 hrs	24 hrs	24 hrs	None	978-HELP for Research
Trinity	8:00-22:00	8:00-22:00	8:00-22:00	8:00-22:00	None	978-HELP for Research
Victoria	8:30-21:00	8:30-21:00	8:00-13:00	8:00-13:00	None	978-HELP for Research

Sites	Advising Hours
CAO	Monday through Friday, 10:00 - 18:00
Erin	Monday through Friday, 09:00 - 22:00

Legend

* Research includes graduates, faculty, staff.

Δ Key access available.

† Access restricted to building hours.

Computer and Printer Access

Sites	PACX	CDF/PC	CQUEST	Printers
CDF				Y
EA	Y			Y*
Erin	Y			Y
Ramsay Wright			Y	Y
Robarts	Y	Y		Y*
Sidney		Y	Y	Y
St. Michael's	Y	Y		Y*
Trinity	Y			
Victoria	Y			

(Y=yes, N=no)

* Public Printers

UTCS administers a number of software site licenses available to the University of Toronto community. (Usually, this means faculty, staff, and graduate students, though some licenses apply to undergraduate students also. See "Restrictions" in the table below.) The licenses provide a variety of software at much-reduced cost. The majority of the licenses must be renewed each year. Most are terminated when you leave U of T.

Each license has a contract that you must complete. It outlines your responsibilities and any limitations in the use of the software. Except for ProComm, the contracts and software are available from the UTCS Information Office, 4 Bancroft Avenue, Room 201. ProComm is available from the UTCS Advising Office, 978-HELP. To qualify as a member of the U of T community, you must provide a valid Employee number or Student number.

The table below describes the available site licenses. The Restrictions column specifies who may purchase the license. If the restriction is Research, the payment must come from research money. The Diskettes column describes how you actually receive the software. Large packages, like SAS and SPSS, require that you borrow the diskettes, install the software, and return the diskettes. Smaller packages, consisting of up to five diskettes, either require you to bring your own diskettes or include the cost of the UTCS-supplied diskettes in the license fee.

For more detailed information about these site licenses, telephone the UTCS Information Office at 978-4990.

Site Licenses at UTCS

Product Name	<i>Archivist</i>	<i>Chaos in the Classroom I: Maps and Bifurcations</i>	<i>ProComm</i>
System	PC; Text management	PC;	PC; Communications
Restrictions	Faculty, Staff, Graduate Students	Faculty, Staff, Graduate Students	Faculty, Staff, Graduate Students, Undergraduate
Cost	\$40	\$12	Free
License Period	One-time fee	One-time fee	N/A
Diskettes	One 5.25"; bring own	One 5.25" or one 3.5"; bring own	Two 5.25"; bring own
Documentation Available at UTCS	No	Yes	On disk; part of package
Product Name	<i>QuickMail</i>	<i>SAS/PC</i>	<i>SAS/PC network</i>
System	Mac; Electronic mail	PC; Statistical analysis	PC; Statistical analysis
Restrictions	Faculty, Staff	Faculty, Staff, Graduate Students, Undergraduate	Faculty, Staff, Graduate Students
Cost	\$35 per user Upgrades: \$10	BASE/STAT/GRAPH/FSP: \$70; IML module: \$20; ETS module: \$35.	\$35 per station
License Period	One-time fee	July 1-June 30	July 1-June 30
Diskettes	One 3.5"; bring own	Deposit per binder Maximum \$350	Deposit per binder Maximum \$350
Documentation Available at UTCS	No	Yes	Yes

Site Licenses at UTCS *cont.*

Product Name	SAS/UNIX	SPSS/PC	SYSTAT
System	UNIX; Statistical analysis	PC; Statistical analysis	Mac; Statistical analysis
Restrictions	Faculty, Staff, Graduate Students	Research	Faculty, Staff, Graduate Students
Cost	\$150 BASE; \$50 ea. FSP, IML modules	\$100	\$100
License Period	July 1-June 30	Nov 1-Oct 31	July 1-June 30
Diskettes	Tape cartridge	Deposit \$25 per box; 2-3 boxes	Five 800KB 3.5" diskettes; bring own
Documentation Available at UTCS	Yes	No	Yes
Product Name	WATFOR-77	WordPerfect	
System	PC; FORTRAN compiler	PC; Word Processing	
Restrictions	Research	Faculty, Staff	
Cost	\$35 [\$35 WATFOR-87 (math co-processor)]; Add \$5 GKS (Graphics Kernal System)	New: \$65 Upgrade: \$10	
License Period	July 1-June 30	One time fee	
Diskettes	Two-three 5.25" diskettes; bring own	Deposit \$25 per box; 1 box	
Documentation Available at UTCS	Yes	Yes	

Software List for Microcomputers

The following are microcomputer software packages for which UTCS can provide either support or some information. As with mainframe products, micro packages receive full support (Class A), limited support (Class B), or no active support (Class C). The specific criteria differ from those for mainframe classes and are outlined in the Academic's Guide to Microcomputer

Package/Compiler	Version	Environment	Support
Application Development Tools			
Assembler			
Microsoft Assembler	5.1	MS-DOS 3.3 & OS/2	B
MPW Assembler	2.0.2	Macintosh	B
BASIC			
GW BASIC	—	MS-DOS	B
C			
Microsoft C	5.1	MS-DOS	B
MPW C	2.0.2	Macintosh	B
WATCOM C & Express C	6.0	MS-DOS	B
Modula-2			
JPI Top Speed Modula-2	1.17	MS-DOS	B
Metacom Modula-2	1.0	Macintosh	C
FORTRAN			
IBM FORTRAN/2	1.0	MS-DOS 3.3 & OS/2	B
Language Systems FORTRAN	1.0	Macintosh	C
Microsoft FORTRAN	4.0	MS-DOS	B
WATCOM WATFOR-77	3.0	MS-DOS	A
Pascal			
MPW Pascal	2.0.2	Macintosh	C
TURBO Pascal	—	MS-DOS	B
Tools			
ResEdit	1.2	Macintosh	B
HyperCard	1.2.5	Macintosh	A
Macintosh Programmer's Workshop	2.0.2	Macintosh	B
SuperCard	1.0	Macintosh	B
WATCOM GKS	1.3	MS-DOS	B
Communications			
File Transfer & Terminal Emulators			
Kermit	0.8(35)	Macintosh	A
Kermit	2.30	MS-DOS	A
DeskLink	2.21c	MS-DOS	B
Lap-Link Mac	2.00a	Macintosh	B
Lap-Link PC	2.16	MS-DOS	B
MacTerminal	2.2	Macintosh	B
PC TALK3	—	MS-DOS	C
PC PLOT III	—	MS-DOS	C
ProComm	TU 2.4.2	MS-DOS	A
Red Ryder	10.3	Macintosh	B
Remote ²	1.01	MS-DOS	B

Software List

Software List for Microcomputers *cont.*

Package/Compiler	Version	Environment	Support
Network Systems			
3COM PLUS	1.3.1	MS-DOS	B
AppleShare	2.0.1	Macintosh	B
Novell Advanced Netware	2.15	MS-DOS	B
PC LAN	1.3	MS-DOS	B
STARLAN	3.1	MS-DOS	B
Tapestry II	1.1B	MS-DOS	B
TOPS	2.1	Macintosh	B
TOPS	2.1	MS-DOS	B
TOPS NetPrint	2.1	MS-DOS	B
Network System Utilities			
Inter•Poll	1.0.1	Macintosh	B
Database Managers			
4th Dimension	Int. 1.03	Macintosh	B
Archivist	1.02b	MS-DOS	B
AskSam	4.2	MS-DOS	B
Clipper	S87	MS-DOS	B
DATAEASE	2.5R3	MS-DOS	B
dBASE IV	1.1	MS-DOS	A
FileMaker II	1.1	Macintosh	B
FoxBASE Mac	2.01	Macintosh	A
FoxPro	1.0	MS-DOS	B
Notebook II	2.03	MS-DOS	C
Oracle	5.1B	MS-DOS	B
Oracle for Macintosh	1.1	Macintosh	B
R & R Report Writer	3.0	MS-DOS	C
Desktop Publishing			
Fontographer	n/a	Macintosh	C
PageMaker	3.02	Macintosh	A
PageMaker	3.0	MS-DOS	A
PageMaker	3.0	OS/2	C
Quark XPress	1.0	Macintosh	C
Ready,Set,Go!	4.0	Macintosh	C
Ventura	2.0	MS-DOS	B
Electronic Mail			
Microsoft Mail	1.36	Macintosh	B
QuickMail	2.3.2	Macintosh	B
Graphics			
Charting			
35mm Express	4.02	MS-DOS	B
Cricket Graph	1.2	Macintosh	C
Freelance Plus	3.0	MS-DOS	B
Harvard Graphics	2.1	MS-DOS	B
Lotus 1-2-3	2.01a	MS-DOS	B
Microsoft Excel	1.5	Macintosh	B
Microsoft Excel	2.0	MS-DOS	B
SigmaPlot	—	MS-DOS	C
Draw and CAD			
Aldus Freehand	1.0	Macintosh	B
Cricket Draw	1.1	Macintosh	C
Generic CADD	3.0	MS-DOS	C
MiniCad	4.05	Macintosh	C
Illustrator	1.0	Macintosh	B
Illustrator88	1.6	Macintosh	B

Software List for Microcomputers *cont.*

Package/Compiler	Version	Environment	Support
MacDraft	1.2b	Macintosh	C
MacDraw	1.95	Macintosh	A
MacDraw II	1.0v1	Macintosh	B
Windows Draw	1.02	MS-DOS	C
Image and Scanning			
Corel Draw	1.00	MS-DOS	B
ImageStudio	1.05	Macintosh	B
Publish Pac	2.0	Macintosh	B
Publish Pac	2.1	MS-DOS	B
Text Pac	2.0	MS-DOS	B
Paint			
DR HALO	1.23	MS-DOS	C
MacPaint	2.0	Macintosh	A
Microsoft Paintbrush	2.0	MS-DOS	C
PC Paintbrush	2.5	MS-DOS	C
SuperPaint	1.1	Macintosh	B
Windows Paint	2.03	MS-DOS	C
Plotting Subroutines			
WATCOM GKS	1.3	MS-DOS	B
Numerical			
Derive	1.14	MS-DOS	C
Eispack	n/a	MS-DOS	C
Eureka	n/a	MS-DOS	C
GAUSS	2.0	MS-DOS	B
Linpack	n/a	MS-DOS	C
MathCAD	2.0	MS-DOS	C
muMATH-83	4.12	MS-DOS	C
NAg Workstation Library	Rel. 1	MS-DOS	A
Solver-Q	---	MS-DOS	C
Operating Systems			
IBM PC, PS/2, and compatibles			
IBM OS/2 Extended	1.2	n/a	B
IBM PC-DOS	4.0	n/a	A
Microsoft MS-DOS (incl IBM PC-DOS)	3.3	n/a	A
Microsoft Windows 286	2.1	MS-DOS	A
Microsoft Windows 386	2.1	MS-DOS	A
Microsoft Windows	3.0	MS-DOS	A
Macintosh II, Macintosh SE, and Macintosh Plus			
A/UX (Unix)		n/a	C
Finder	6.0.5	n/a	A
MultiFinder	6.0.5	n/a	A
System	6.0.5	n/a	A
NeXT			
NeXT	1.0	n/a	B
Sound			
SoundWave	1.0	Macintosh	B
MacRecorder	1.0	Macintosh	B
Spreadsheet			
HAL	1.0	MS-DOS	B
Lotus 1-2-3	2.01a	MS-DOS	B
Microsoft Excel	1.5	Macintosh	B

Software List for Microcomputers *cont.*

Package/Compiler	Version	Environment	Support
Microsoft Excel	2.0	MS-DOS	B
Statistical			
BASS	88.10	MS-DOS	C
MACSPIN	1.5	Macintosh	C
Minitab	82.1.1	MS-DOS	C
PowerStat	1.04	MS-DOS	C
SAS/PC	6.03	MS-DOS	A
SPSS/PC+	3.0	MS-DOS	A
STATPRO	2.0c	MS-DOS	C
STATWORKS	1.2	Macintosh	B
SYSTAT	3.2	Macintosh	B
SYSTAT	3.2	MS-DOS	B
Word Processing			
Guide	2.0	MS-DOS	C
MacWrite	5.01	Macintosh	B
Manuscript	2.0	MS-DOS	C
Microsoft Word	3.02 & 4.0	Macintosh	A
Microsoft Word	4.0 & 5.0	MS-DOS	A
Microsoft Word for Windows	1.0	MS-DOS	B
Nota Bene	3.0	MS-DOS	B
Nota Bene SLS	3.0	MS-DOS	B
PC-TeX	2.1	MS-DOS	B
Sprint	1.0	MS-DOS	B
WordPerfect	5.0 & 5.1	MS-DOS	A
WordPerfect	1.0	Macintosh	C
WordPerfect Library	2.0	MS-DOS	C
WordStar	3.3 & 5.5	MS-DOS	C
Utilities			
Apple Turnover	—	MS-DOS	A
Fastback MAC	2.0	Macintosh	B
Fastback Plus	2.0	MS-DOS	B
Lotus Magellan	2.0	MS-DOS	B
MacTools Deluxe	1.0	Macintosh	B
Mace Utilities Gold	—	MS-DOS	B
MacZap	5.1	Macintosh	B
Norton Utilities	5.0	MS-DOS	A
Retrospect	1.1	Macintosh	B
Sidekick for PM	1.0	OS/2	C
Stuffit	1.5.1	Macintosh	A
XenoCopy PC	1.117	MS-DOS	A
386MAX	4.0	MS-DOS	B

Software List for Mainframe Computers: VM/CMS, UNIX

Each programming language or package available at UTCS has a support level. In general, Class A Products receive full support, Class B limited support (as time and resources allow), Class C no active support.

For complete details of UTCS product support policy, see the UTCS GUIDE TO PRODUCTS AND SERVICES: Introduction.

Package/Compiler	System	Support	Version
Communications			
FTP	VM/CMS	C	1.2.1
Kermit	VM/CMS	A	---
Kermit	UNIX	B	4C(058)
FTS	VM/CMS	A	---
MAIL/MAILBOOK	VM/CMS	A	86.359
macget/macput	UNIX	C	---
netcopy, netexec, to (NetNorth Tools)	UNIX	B	---
xmodem	UNIX	C	---
ftp,rsh,rlogin,telnet,rcp (Access via TCP/IP to most of the networked machines on all three campuses)	UNIX	B	---
rn/Pnews	UNIX	B	---
mail,mh,Mail	UNIX	-	---
TELNET	VM/CMS	C	1.2.1
Graphics			
PLOTBASIC (FORTRAN)	VM/CMS	C	---
SAS/GRAPH	VM/CMS	A	5.18
Languages			
ASSEMBLER(F)	VM/CMS	C	---
Concurrent Euclid	VM/CMS	C	1.9
FORTUTILS	VM/CMS	A	2.2
PL/I OPT Compiler	VM/CMS	B	1.5.1
REXX	VM/CMS	A	---
SNOBOL 4	VM/CMS	C	3.5
Turing	VM/CMS	C	---
VS FORTRAN	VM/CMS	A	1.4.1
VS Pascal	VM/CMS	C	2.2
Waterloo C	VM/CMS	C	1.3
WATFIV	VM/CMS	C	V2L0
WATFOR-77	VM/CMS	A	1.3
cc	UNIX	A	---
f77	UNIX	C	---
ratfor	UNIX	C	BSD std.
ttc	UNIX	C	---
pc	UNIX	C	BSD std.
yacc	UNIX	C	---
awk	UNIX	C	---
adb,dbx	UNIX	C	BSD std.

Software List

Software List for Mainframe Computers *cont.*

Package/Compiler	System	Support	Version
Numerical			
IMSL	VM/CMS	A	9.2, 10.0
LINPACK	VM/CMS	C	---
MINOS	VM/CMS	C	5.1
MINPACK	VM/CMS	C	---
NAG	VM/CMS	A	Mark 11, 13
Statistical			
BMDP	VM/CMS	A	Level 85, Level 87
Minitab	VM/CMS	B	5.1
NAG	VM/CMS	A	Mark 11, 13
NTSYS	VM/CMS	C	1987
SAS	VM/CMS	A	5.18
SPSS*	VM/CMS	A	3.1
Text Processing			
SCRIBE	VM/CMS	C	4(1400)-1
Waterloo SCRIPT	VM/CMS	B	86.1
XEDIT	VM/CMS	A	---
8700 Pseudotypesetting	VM/CMS	C	n/a
MICROLASER	VM/CMS	C	---
ed	UNIX	A	---
vi	UNIX	C	---
cmacs	UNIX	C	---
spell	UNIX	C	---
diction/explain	UNIX	C	---
eqn	UNIX	B	---
tbl	UNIX	B	---
pic	UNIX	C	---
troff	UNIX	B	---
nroff	UNIX	B	---
TeX	UNIX	C	---
Utilities			
FORTUTILS	VM/CMS	A	2.2
TPRINT	VM/CMS	C	---
TCOPYNL	VM/CMS	B	---
TCOPYSL	VM/CMS	B	---
crypt	UNIX	A	BSD std.
compress	UNIX	C	BSD std.
csh	UNIX	B	BSD std.
diff	UNIX	A	BSD std.
grep	UNIX	A	BSD std.
ipr	UNIX	B	---
learn	UNIX	C	BSD std.
patch	UNIX	C	---
sed	UNIX	A	BSD std.
sort	UNIX	A	BSD std.
sh	UNIX	A	BSD std.
tar	UNIX	A	BSD std.
uniq	UNIX	A	BSD std.

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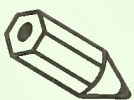
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